OIL

The New Monarch of Motion

BY

Reid Sayers McBeth

OIL

THE NEW MONARCH OF MOTION

First Oil Well
E. L. Drake (right foreground)

OIL

THE NEW MONARCH OF MOTION

AN UNBIASED PRESENTATION OF THE WHOLE OIL INDUSTRY. WRITTEN ESPECIALLY FOR THE INVESTOR WHO DESIRES THE FACTS

BY

REID SAYERS McBETH

Author of
"PIONEERING THE GULF COAST"

NEW YORK
MARKETS PUBLISHING CORP.
1919

FOREWORD

SINCE we asked Mr. McBeth, some two months ago, to write "Oil—The New Monarch of Motion," the whole investing world seems, in the words of a famous New York newspaper, "to have joined in a mad scramble for fortunes in oil."

It was to furnish the intending investor rather than the casual reader or student an impartial up-to-date book on oil that I proposed this edition. I hope we have succeeded in producing a book which, while comprehensive and accurate, is as free from bewildering technicalities as the highly intricate subject allows.

Confirmative of our belief that this book would introduce oil at its very beginning of greater world-wide usefulness, is the following extract from an article on oil by Mr. Edward L. Doheny, in *Hearst's Magazine* for April, 1919:

"The whole oil industry is only in its formative stage, the motorization of the world

has scarce begun. Ere long oil-driven machinery will enable man to conquer the air, till the soil, utilize the seas, accelerate communication on a scale not dreamed of to-day. We are about to enter the oil age—the age of motorization."

EDMUND J. RYAN,
Secretary-Treasurer, Markets Publishing Corporation.

ACKNOWLEDGMENT

THE aim of this book is to touch briefly on the essential phases of the petroleum industry in such manner as to give the layman in condensed form an idea of its growth, vast scope and possibilities.

More comprehensive and technical information is contained in Johnson and Huntley's "Oil and Gas Production" and Bacon and Hamor's "The American Petroleum Industry," both of which have been of great benefit to the writer of this volume.

"The Derrick's Handbook of Petroleum" of the Derrick Publishing Company, Oil City, Pa., also has been of great assistance in the compiling of material for the chapters on the early history of the industry. This and other aid is gratefully acknowledged.

TABLE OF CONTENTS

CONTENTS

I

PETROLEUM, THE FORTUNE MAKER

PETROLEUM is the fuel and lubricant of speed and mechanical efficiency—on land, on the sea, under the sea, in the air.

Practically every human activity is dependent upon it in some degree.

The first oil well in America was drilled in 1859—only sixty years ago!

But it is only in the last decade that petroleum really has begun to come into its own.

This period has seen the perfection of the internal combustion engine, upon which the automobile, the aeroplane, the farm tractor, motor boats, the submarine, and many other efficient mechanical contrivances depend.

Likewise it has seen the beginning of an era of fuel oil for railway and marine transportation that gives evidence of becoming one of the most brilliant phases of the oil industry's golden career.

Petroleum has built the world's greatest individual fortune—that of John D. Rocke-

feller, who is credited with being the first billionaire.

And there are hundreds upon hundreds of others whose fortunes it has made—sometimes overnight.

It is in the last decade that the Rockefeller and other early oil fortunes have made their most rapid growth. And there has been a vast increase in the last ten years in the number of great new fortunes produced by oil.

Petroleum to-day holds the front of the stage in a greater degree than ever before. As a wealth creator it never has been so fruitful as at present.

The world's oil fortunes are largely American fortunes, for the fields of the United States supply approximately two-thirds of all the petroleum consumed by all the peoples of the globe.

And again the Mid-Continent field, embracing the states of Oklahoma and Kansas, Northern Louisiana and Northern Texas, is estimated in 1918 to have contributed 42% of our country's output.

The Mid-Continent field including Texas, therefore, may be regarded as the greatest

present producer of petroleum wealth in the United States.

John D. Rockefeller, entering the oil business about 1865 in the old Pennsylvania territory, was carried by the industry to the position of wealthiest man in the world's history. His fortune and those of his associates, however, have experienced their greatest growth in recent years—the wealth to be taken out of the oil industry is becoming greater rather than less.

Rockefeller and those who joined with him have been the greatest individual beneficiaries because they, early in their careers, realized something of the importance of the position petroleum was destined to occupy—and they pinned their faith to this realization.

Because of the suddenness with which it has made wealth, the history of petroleum almost from the very inception of the industry is fraught with the keenest interest. Oil companies and individual operators have suddenly become immense producers of wealth, and land owners under whose perhaps barren acres petroleum has been found have been elevated to opulence. Each new oil field has been responsible for new fortunes.

Outstanding among the creators of new wealth, both in California and Mexico, is Edward L. Doheny, who in the early 90's declared he was not worth $40—and who as this is written is many times a millionaire, with his far-flung financial plans just beginning to bear fruit.

It was in the Mid-Continent field that W. A. McFarlin and five associates built up a group of producing properties which they disposed of in 1917 for $35,000,000. It was in this field that the vast McBride estate, estimated at some $40,000,000, was built.

Who has not heard of J. S. Cosden and H. F. Sinclair? Their rise to the height of millionaires has been accomplished in much less than a decade. Both these men are now at the head of great independent oil organizations.

Then there is John W. Crawford, who made his first thousands in the Illinois field and now is running it into millions for himself and his associates in Oklahoma, Kansas and Texas.

W. A. Springer, a former oil field worker, and Dr. S. G. Kennedy, whose homes are among the show places in the remarkable

city of Tulsa, Oklahoma, sold out their half interest in a lease in the Osage district of Oklahoma in 1917, for more than $6,000,000!

Roy M. Johnson, owner of rich producing acreage in the Healdton field of Oklahoma, formerly was editor of a small weekly newspaper, at the same time being his own linotype operator.

New fortunes are now being made with a rapidity that almost dizzies one by oil men, ranchmen and farmers in the Ranger and Burkburnett districts of North Central Texas. Practically all the original inhabitants of the towns of Ranger and Burkburnett have made unusual amounts of money since this new field was opened.

And the Ranger field was opened by a coal company that had a vision which went beyond the mining of coal and the baking of tile and brick.

The foregoing is not intended to convey the impression that an uninformed and penniless individual could go to the oil fields and find wealth leaping abundantly into his outstretched arms.

The individuals here referred to have in most cases combined business and scientific

sagacity with persistency. Of course there have been cases that hardly could be characterized as other than pure "luck," but it is not well to depend upon that fickle element in any business.

It is related that shortly after J. S. Cosden purchased his first small refinery a tornado came along and scattered it to the four points of the compass. Cosden then laboriously rebuilt the little plant—only to have it destroyed by fire before it had entered the profit-making column.

But this did not deter this former oil-supply salesman. He scraped around and obtained money to build again—and now his company has one of the largest and most modern refineries in the United States, a $17,000,000-plant!

Mr. Springer was an oil-field worker for 40 years. He toiled in the Pennsylvania, West Virginia and Ohio fields before going to Oklahoma with one of the first firms that turned toward that territory—never, by the way, having had an opportunity to attend school for a single day.

Faithful to his employers, he purchased many leases, but never took advantage of

opportunities to operate clandestinely for his own gain.

Finally he expressed to his employer a desire to purchase acreage at one of the Osage Indian lease auctions. The employer agreed readily, even providing the use of his own geologist to select the acreage.

Then to help finance the project he enlisted the aid of Dr. Kennedy, who had married a member of the Osage tribe and is widely versed in Osage affairs.

Dr. Kennedy did the bidding, so that other bidders would not suspect that Mr. Springer's employers were seeking the property and consequently place a high valuation on it. The 4,780 acres were obtained for a bonus of \$1.10 an acre—\$5,280 for a property that afterward sold for more than \$12,000,000!

The two men obtained title early in 1913. After many rebuffs they were able, in return for a one-half interest, to get a prominent drilling firm to agree to develop the acreage. A few small oil and gas wells were completed. Then the sudden drop in oil prices as a result of the flood of oil from the famous Cushing field halted drilling.

Finally the drilling firm disposed of its

half-interest—at a price variously estimated at from $25,000 to $50,000. This was just before the first deep well on the lease "came in" with a flow of 75 barrels an hour, or 1,800 barrels a day. Shortly followed a well flowing 180 barrels hourly and then another that produced more than 200 barrels an hour, or close to 5,000 barrels a day.

The Springer family had been living on the barren lease far back in the scrub oak-covered Osage hills. Affluence suddenly took the place of poverty. The lease that oil men formerly had discussed with many shakings of their heads became a possession much to be desired. Finally, early in 1917 the Kennedy-Springer half interest was sold for more than $6,000,000.

And shortly thereafter a company presided over by one of the members of the drilling firm that had sold its half for $25,000 to $50,000 purchased that self-same half share for upward of $6,000,000!

This is only one story of reward for faith and persistency in oil.

There is in Oklahoma a man who, because of the fact that the wells he drilled almost invariably proved "dry holes," acquired the

cognomen of "Hard Luck." But he was persistent—he knew he would strike it some day. At last the situation came to such a pass that there was no more money in sight—and his drillers had to be paid. He hardly knew how to tell the drillers.

He procrastinated, deciding to sleep at the lease that night. Perhaps he would have the temerity to tell the men the next day.

In the early morning hours he was awakened by joyful shouting.

The well had "come in"—and it showed a flow of several hundred barrels a day. Since that time his drilling fortune has been so uniformly excellent that the oil men have discarded the old "Hard Luck" and have dubbed him "Lucky."

This man is now at the head of a growing oil company and well on the way to become a millionaire.

The accomplishment of Capt. Anthony F. Lucas in completing the great 100,000-barrel Spindletop "geyser" near Beaumont, Texas, in 1901 is another instance of the reward for persistency—not blind persistency but a faith based on scientific deductions.

This well meant the discovery of the Gulf

Coast district, which extends along the coastal plain of Louisiana and Texas.

Capt. Lucas met rebuff after rebuff in his endeavor to obtain financial backing. He was compelled to devise new drilling methods to combat the heavy back pressure that was encountered as depth in drilling was attained.

Success finally crowned his efforts and a field was discovered that has been responsible for the organization and growth of some of the nation's most prosperous oil companies.

Where the "luck" element plays its most prominent part is among holders of land under which oil is found. The Osage Indians of Oklahoma, for instance, now are regarded as the wealthiest people per capita of any community in the world. Their income in 1918 in oil royalties and bonuses from tribal lands was approximately $4,000 for each individual.

These Indians are among the largest buyers of automobiles in the country. It is common to see a gaudily blanketed Indian, corpulent of figure and inscrutable of countenance, driving into an Osage town in the latest model of one of the higher priced cars.

Individuals of the Creek and other Indian nations frequently have incomes from oil that would make even a war profiteer envious.

The discovery of oil in the Ranger field of North Central Texas came as a Godsend to many of the struggling farmers of that section.

A drouth of two years' duration had preceded the finding of oil. Crops had been burned up and the grass had withered. Water was scarce. The cattle had either died or were sold at a sacrifice. In numerous instances land owners were compelled to dispose of part of their holdings to provide for the payment of taxes on the remainder. The Governor of the State raised a large sum of money by subscription to aid the stricken farmers, many of whom had to abandon their scorched farms in order to earn a living.

Then came oil—and wealth!

Here is a typical story told in the new Texas oil fields. A large well was completed on a barren farm. The farmer had just been offered $500,000 for the land. He rushed to his wife to break the glad news.

"Well, Mary, I got a half million dollars

now," he shouted, "and I want to do something for you."

She considered the offer a few moments and then replied:

"I wonder if we could get a new axe. The old one has a nick in it!"

Here is another oil boom tale (which may or may not be true—probably not).

The farmer's wife had been patient and economical through all their tribulations. She could not believe that oil might bring them wealth, even if their neighbors were basking in money. When her husband returned from town one day and told her he had received $100,000 for a lease on part of the farm, she immediately jumped at the conclusion that he had been drinking!

Finally he took her to the bank and the cashier assured her that there was a deposit of $100,000 to the credit of her husband. They parted at the bank, meeting next at home. There she proudly displayed a bottle of olives.

"What are those?" the farmer demanded,

"They are olives. All the best hotels have them. I thought we could now afford them, too."

"No, we can't," he shouted. "That's extravagance, and we won't begin now. You take 'em right back to the store!"

It is related that a young farmer near Ranger, made wealthy by oil, was wearing an expression one day that betokened such distress that a solicitous neighbor immediately jumped to the conclusion that financial disaster had overtaken him.

The trouble really was that the young man was fretting because of the difficulty of obtaining labor to pick his cotton. The oil boom which had brought him fortune was being maligned by him because it was interfering with his cotton picking!

These are a few cases that smack of the romantic and even of the humorous inconsistencies that make the oil business so full of fascination—and lure.

The staunch, going-concern, the great organization end of the business is equally as fascinating—because it is from it that concrete figures may be obtained regarding the immense profits accruing to stockholders in well-managed oil producing, refining and marketing companies.

Shares in the great majority of these con-

cerns are purchasable in the established exchanges of the country—and anyone may buy them who has the enterprise to accumulate surplus money.

The companies of the Standard Oil group, for instance, in the seven years following the dissolution order in 1911 paid $587,742,787 in cash dividends.

The outstanding capital of the companies at the end of the period mentioned aggregated slightly more than $532,000,000.

At the beginning of the seven years the outstanding capital was very much less, the stockholders at not infrequent intervals receiving valuable stock dividends or rights to purchase new stock at a price greatly below the market valuation. These extra disbursements probably were more valuable even than the cash return, which in seven years was more than 100% on the capital outstanding at the end of the period.

The Standard Oil companies in the first quarter of 1919 paid $26,950,110 in cash dividends and approximately $2,494,330 in Liberty Bonds. This was at the rate of almost $118,000,000 annually, or more than 20% on the capitalization of the companies!

A constant growth in cash disbursements has been shown since 1912, when the total was $51,786,624.

Athough because of their number and the fact that it would be impossible to assemble dividend data on all the independent companies, the record of those possessing capable and progressive managements reads the same as that of the Standard Oil companies.

It is a fascinating tale of a brand of prosperity that is increasing as the world's dependence on petroleum becomes more and more complete.

II

THE WORLD'S DEPENDENCE ON OIL

PETROLEUM and progress are so closely wedded in the nation's history as to be almost synonymous.

Hardly a phase of modern human endeavor but what involves in some manner the use of a product of petroleum. Not a wheel turns which is not dependent on petroleum for lubrication.

Without petroleum the internal combustion engine could not have been developed. And it is this type of engine that makes possible the automobile, aeroplane, motor boat and submarine—with their immense appetites for gasoline and lubricating oils. And many of the ocean passenger, cargo and warships of the future undoubtedly will use this type of engine. In fact, it already is used in passenger and cargo vessels of small tonnage.

Oil-burning ships of great tonnage, including super-dreadnaught battleships, of course, are numerous.

THE WORLD'S DEPENDENCE ON OIL

Petroleum lubricates the wheels of progress—the machinery that generates the electricity, and the bearings of the trains that are driven by the electricity.

Germany's lines of communication broke down largely because of a shortage of gasoline for motor cars and lubricants for both motor cars, artillery and railway equipment.

The United States and her Allies were able to overwhelm their enemies largely because the oil producers of the United States saw to it that there were adequate supplies of petroleum rushed across the sea. The Allies, in the words of Lord Curzon of England, "floated to victory on a wave of oil."

From crude oil there are obtainable more than 300 products. The principal ones, of course, are naphtha, gasoline, benzine, kerosene, gas oil, illuminating oil, lubricating oil, fuel oil and various kinds of greases.

In addition there are paraffin, asphalt products, soaps, medicinal oils and a multitude of variations of these products for special uses.

There were estimated at the beginning of 1919 to be some 5,500,000 or 6,000,000 motor vehicles in use in the United States. Nat-

urally this means an immense demand for gasoline and lubricants.

Steamship companies, because of oil's superiority in practically every respect, are turning to fuel oil to supply power for their vessels. Ton for ton, as compared to coal, oil gives greater mileage, occupies less space, requires fewer men in the fire room (thereby also accomplishing a saving of space in the men's quarters), cuts down time required for bunkering, gives an even heat, and is much more cleanly.

Numerous railway companies and manufacturing concerns also are adopting oil as fuel largely for the same reasons. Already it appears that fuel oil shortly will be pressing gasoline closely as the petroleum product in greatest demand.

The cleaning industry uses millions of gallons of the lighter petroleum distillates annually. In fact, prior to the advent of the automobile this was the principal outlet for gasoline. The most sought-after petroleum product in those days was kerosene, or "coal oil." The situation now has been largely reversed; the "coal oil" lamp is almost extinct, except in some country districts.

But the oil companies have found a large foreign demand for the product. This is being developed. The domestic consumption also is being kept up to a substantial mark by the oil companies pushing the sale of kerosene stoves and other similar devices.

The manufacture of artificial gas, with which practically all the cooking in cities is done, involves the use annually of millions of gallons of gas oil, a petroleum product. This is used for enriching the gas.

The housewife uses laundry soap that probably contains a large percentage of material derived from petroleum. In the ironing she uses a wax, which is paraffin. A coating of paraffin also is poured over the cups of jelly. The dressing for the hardwood floors and the furniture polish both in all probability are petroleum products. And, again, the oil for the sewing machine, lawn mower, bicycle, etc.

The modern oil refinery makes almost as complete disposition of crude oil as do the packing plants in their utilization of the by-products of the hogs and cattle that they slaughter. Nowadays there is little remaining of the crude oil when the refining opera-

tion has been carried out to the limit. The amount of residuum in some cases is as low, or even lower than 5%.

High-salaried chemists are employed by the large oil companies to evolve means of utilizing the by-products to the fullest extent. More and more attention is given to the problem of squeezing the last ounce of gasoline out of crude petroleum—because gasoline is the most readily marketed of the products.

A few years ago a great many petroleum by-products were wasted by being lumped off together as fuel oil. This is not true to-day. Markets are being made for the various products, or, if no market appears available for a petroleum derivative in its original form, the company's chemists are set to work to evolve from it a product for which it is possible to create a market demand.

Petroleum road oil is an evolution of recent years. Automobiles increased the dustiness of roads. Likewise they proved the greatest single factor in adding impetus to the movement for better highways, increasing the demand for road binders and asphalt, both of which are obtained from petroleum.

How fortunately the development of the motor vehicle worked out in its relation to petroleum! Gasoline, of course, is the product having the closest relationship to the automobile. And in refining the requisite amount of gasoline, the refiners were compelled to produce more of the liquid that came to be known as road oil. Automobiles are responsible in a large degree for both—dusty roads and the viscous petroleum by-product. Happy thought—make them neutralize each other!

So automobiles are responsible in a large measure both for the production and consumption of road oil and various asphalt road-building materials.

How large a part is played by road oil may be judged by a suburban automobile trip in practically any part of the United States. Not only have the smaller towns acquired the habit of oiling their streets in the summer months, but in many instances farmers far removed from towns have taken it upon themselves individually to oil a stretch of highway for a short distance either way from their places of abode to prevent dust from interfering with their comfort,

cleanliness and crops, and marring the beauty of their homes.

Of special service to the farmer also are a variety of disinfectants or "dips" that play a large part in the health and well being of farm animals. The sale of these disinfectants is not confined to the country districts either, but the products find numerous uses in cities. Heavy greases find a large sale as rust preventatives for farm and factory tools that are not in constant use.

Under the general heading of lubricants come a variety of petroleum by-products, the limit to which depends both on the demand and the ingenuity and efficiency of the refiner and his scientific staff. A catalogue of one of the great refining companies lists something like thirty different oils and greases —and still it has not covered the whole list.

The lubrication list extends from heavy axle greases to a light oil that insures the smoothness of action of milady's tiny wrist watch, and spindle oils adapted to the lubrication of the swiftly revolving spindles in a cotton mill.

To develop to the most profitable extent the market for these various lubricants re-

quires distinctive advertising and sales methods. Oil for gas engines, for instance, is advertised by the refiner or distributor in mechanical and , engineering publications. Sales of axle grease, threshing machine oil, harness oil, animal "dips" and various other products are sought through the medium of farm publications.

From petroleum that has a paraffin base naturally comes a considerable quantity of that substance. It goes on the market as refined paraffin and is sold in large quantities, especially in the fruit canning and jelly making season.

It provides a sanitary and air-tight covering for preserves. It goes into the making of candles for every conceivable use and occasion. It is the principal ingredient in cheese coating, a substance which is declared to prevent cheeses from becoming contaminated by dirt or insects. The housewife's ironing wax, put up so neatly with a covering of heavy fabric and a convenient wooden handle, is another agency for utilizing this petroleum by-product.

Even crayons used for marking in various colors come—from an oil well!

To indicate to what a fine point the oil industry has been developed; to show how far removed it may become from just "coal oil" and gasoline, note the following, which appears in an oil company's specialty catalogue, accompanied by a colored illustration of the article concerned:

"Jewish Tumbler Candles—These are used almost exclusively for burning by the Jewish trade in memoriam for departed relatives and for use during Yom Kippur and other Jewish holidays. Glasses bear an appropriate label printed in Yiddish, explaining the purpose for which they are used. Glass will be equipped with regular tin cover, so that it can be used for preserving jelly, and for other purposes after having been burned. Label also states that the glasses are 'Kosher,' which means clean. Tumbler lights contain no matter which can be offensive to the Jewish religion, such as tallow or pork products."

In order to increase the sales of floor oil and floor dressing some oil companies also distribute floor oilers and mops. Other companies manufacture and sell kerosene lamps and cooking and heating stoves in order to

make more convenient the adaptation of kerosene to these uses.

One of the great oil companies, when the production of gasoline rose to such a point that the kerosene that accompanied the manufacture of the motor fuel threatened to flood the market, sought an outlet in China and India. But the lamps in use in those countries were crude, smoky affairs that continued to be smoky even when kerosene was used. So, said the natives, why buy kerosene?

Then the oil company hit upon the plan of selling lamps also. The lamps cost 11 cents each, and were sold for 7½ cents—but they brought the desired demand for kerosene!

China's working day was lengthened by the introduction of kerosene lighting. One result is a greater production of silk for us, and greater prosperity for the Chinese. Thus does petroleum play its part in the economic destinies of the world's nations.

This gives some idea of the ingenuity exercised in bringing about the use of petroleum. But it is the gasoline and fuel oil demand that really is the backbone of the industry.

The 5,500,000 or 6,000,000 motor vehicles —and more to come—must have gasoline. The great Merchant Marine that the United States is building up is depending upon petroleum fuel. How great this demand will prove may be judged from the fact that the Shipping Board in March, 1919,—with the ship-building program only fairly well started —asked bids for the supplying of some 34,000,000 barrels of fuel oil to take care of the board's requirements for the ensuing year.

Chairman Edward N. Hurley of the Shipping Board estimated late in 1918 that the proposed 25,000,000-ton American Merchant Marine to be operated with oil fuel, as is planned, would consume 150,000,000 barrels yearly if the oil fuel were burned under the ships' boilers. Half this amount would be used, he estimated, if the ships were driven by internal combustion engines of the Diesel type.

Further, Mr. Hurley sees a world ocean tonnage by 1924 of 75,000,000. Operated even with the Diesel type of engine these vessels, he estimated, would consume 200,000,000 to 250,000,000 barrels of crude oil an-

nually. This is approximately one-half of the world's present production.

It isn't likely that all the vessels will use oil—there still are sailing ships in these days of steam and motors. But oil is recognized as a more efficient—and, therefore, more economical—marine fuel than coal and the coming struggle for world trade supremacy is bound to mean a gigantic demand for fuel oil.

British interests, with this struggle in view, were reported early in 1919 to be converting a large majority of their merchant ships into oil burners. This report caused Chairman Hurley to say:

"Just wait until we really get into the business of consuming oil as a substitute for coal. Then a billion gallons or so will look like a small quantity. We will keep thousands of wells doing nothing but supplying our merchant fleet with liquid fuel. We have scores of ships which use oil exclusively, and we expect to convert many of the older vessels into oil burners."

This fuel oil era is just dawning—but the gasoline era is here—it is a gigantic actuality. The motor-driven vehicles at present are

estimated to be consuming gasoline at the rate of approximately 50,000,000 barrels of 42 gallons each annually. The passenger car industry is conceded to be far from its crest, while the motor truck and tractor production is just beginning to accelerate for its upward climb.

More and more is the world depending upon petroleum as its great agency of progress—and the United States is the leader both as a consumer and producer.

The average estimated consumption of petroleum for each individual in the United States in 1918 was from three to three and one-half barrels. Perhaps, with your motor car or your excessive use of cooking gas you used more than your family's quota. Or, perhaps, you paid for a part of your three or three and one-half barrels through railway or traction fares. Anyway, be you man, woman or child, that amount must be credited to you.

III

ORIGIN AND OCCURRENCE

VARIOUS theories have been advanced since the discovery of natural gas and petroleum in explanation of their existence in the earth's crust. There are three distinct theories of origin.

One is the cosmic theory, which holds to the belief that petroleum is a part of original earth substance. Another is that the origin is inorganic, or that it was formed by the chemical combination of various substances coming in contact with each other in the earth's crust. The third, or most widely held belief, is that petroleum and natural gas originally were organic, or animal and vegetable matter.

The cosmic theory is based on the occurrence of small amounts of hydrocarbons in meteorites. This supports the idea that these substances were a part of the original material that entered into the formation of the earth. Scientists accept it to a limited extent, but assert that it could not be respon-

sible for the great deposits of oil and gas in various parts of the world.

Neither is the theory of inorganic origin now accepted generally. Chemists of the past held to it, but actual geological evidence is said to be opposed to it overwhelmingly.

One of the common assumptions made in support of this hypothesis is that large amounts of metallic carbides at great depths react with descending waters and form various gaseous hydrocarbons, which, by heat and pressure and filtration, finally are changed into petroleum and natural gas. The existence of such a circulation on the interior of the earth, however, is questioned.

The theory generally accepted is that petroleum had its origin in organic materials, plant and animal life—principally the former. While some scientists believe that the original material forming both coal and petroleum may have been the same, they agree that conditions under which the two products were formed were not the same. The relation of the original deposit of organic matter to surrounding strata and other conditions, they believe, determined whether the result would be petroleum or coal.

ORIGIN AND OCCURRENCE

It formerly was the opinion of those who believed in the organic theory that petroleum was a product of the natural distillation of coal or carbonaceous matters. Volcanic intrusions are said in a few cases to appear to have converted coal or other similar substances into oil, but the belief now is held by many persons that terrestrial (or land) vegetation does not, as a rule, give rise to petroleum. They ascribe the source of petroleum to the decomposition both of marine-animal and vegetable life. Terrestrial vegetation on the other hand is acknowledged to be responsible for coal.

It is well to explain that scientists are not unanimous in the belief that marine organisms are responsible for petroleum. Many of them do not confine the organic material to the marine classification.

Laboratory experiments and facts observed in nature tend to confirm the general belief that petroleum has been derived from the decomposition of animal or vegetable bodies or both. For example, when the body of an animal or plant is distilled in a closed retort, or undergoes decay in the absence of air, certain gaseous and liquid products are de-

rived. Again, oily water frequently exudes from peat mosses; and marsh gas, the chief constituent of natural gas, bubbles up from every stagnant pool.

There is, therefore, no need of far-fetched chemical theories to explain what is more or less a matter of common experience. The difference of opinion among geologists is as to the manner in which the decomposition has been brought about.

One view is that the great beds of bituminous shales have been the chief sources of petroleum—that the animal and plant remains in those beds have undergone a kind of a distillation or secondary decomposition, resulting in petroleum, which by hydrostatic pressure (or the movement of fluids seeking equilibrium beneath the earth's surface) has been carried to the rock strata in which it is now found.

Oil shale beds are sedimentary in their origin, being composed of particles of clay (and the inorganic materials) which have been carried long distances and re-deposited in water. It is well known that clay has a particular affinity for oily matter. Oily substances floating in muddy water have been

found to attach themselves to suspended particles of clay and sink to the bottom to produce there a stratum rich in oil, which in time would be compressed by the newer overlying strata in the shale.

Much of the petroleum of the shale doubtless was derived from organic matter undergoing decomposition in other and remote strata. This theory is based largely on the Pennsylvania field, and seems more surely than any other to explain the origin of the petroleum found there.

The Pennsylvania oil occurs in a series of sandstone strata which contain few, if any, organic remains and could not, therefore, have been the original source of the oil. These sandstone strata, however, lie in close relation to the bituminous and other shales and, from their porous nature, have served as reservoirs in which the oil, oozing from the shale, has passed and accumulated in large quantities.

The second theory accounts for oil in limestone rock. Believers in this theory assert that petroleum has been formed from the remains of animals or plants in the same rock strata now yielding the oil, the decomposition

having taken place under such conditions that the organism passed directly into petroleum, which since has remained in the rocks where it was formed.

In substantiation of this theory, it is stated that, in some cases, petroleum is found filling the cavities of large fossil shells in the Trenton limestone of Ohio. From some specimens it is stated that nearly a pint of petroleum has been obtained.

It now is commonly believed by scientists that the oil found in limestone has been produced in the rock by direct decomposition of organisms originally inhabiting the water in which the rock was deposited. Moreover, it is believed that for the most part these organisms were animals, since the limestone oil possesses more sulphur and nitrogen, it is of a darker color, of higher specific gravity and has a more rank and disagreeable odor than the shale oil produced in Pennsylvania which probably owes its origin to the decomposition of plants in the manner set forth in the previously mentioned theory.

There also is a difference of opinion as to the conditions under which the organisms have been changed into oil, some holding

that the process has taken place at a high temperature and under great pressure.

Others hold to the view that petroleum, like coal, has been formed at moderate temperatures, and under pressure varying according to the depth of the rock formation. This view is said to be supported by the fact that petroleum is found on the Swedish coast as a product of the decomposition of seaweed, heated only by the sun and under ordinary or atmospheric pressure.

Although there is no direct basis of fact for conclusions regarding conditions of temperature and pressure under which petroleum and natural gas were formed, science generally concedes that destructive distillation, carried on through thousands of years, of the remains of the plants and animals which either grew or were deposited in the water that permeated the shale beds as the various strata were laid down, is responsible for these great stores of liquid wealth.

Petroleum has been found at depths varying from 80 or 100 feet below the earth's surface to depths of more than 4,000 feet. In fact, the tendency is continuously toward deeper and deeper drilling. This deep drill-

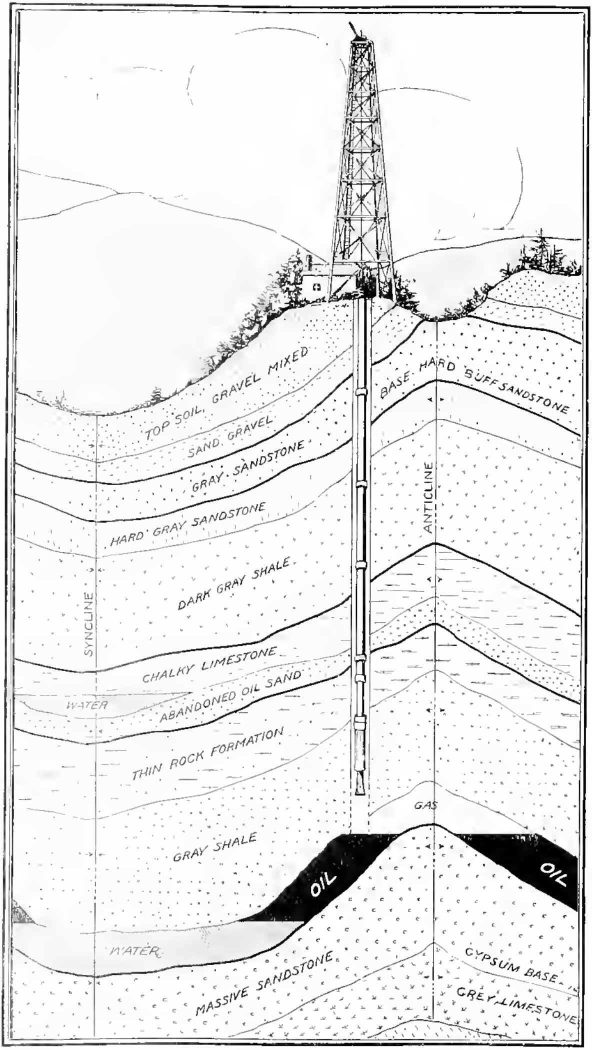
ing not only has resulted in new productive sands being disclosed underlying old fields, but also the discovery of entirely new producing districts.

Petroleum and natural gas usually are found in close proximity. The oil driller takes the presence of gas as a favorable, but not infallible indication.

In the eastern central section of Indiana a gas field was opened many years ago. Finally the gas supply began to fail and, in an endeavor to replenish it, deeper drilling was resorted to. The result is that the territory became a rich oil field.

The deposits of petroleum thus far exploited commercially have been confined to rock formations younger than the Cambrian and older than the Quaternary, which are perhaps millions of years old. Indications, however, have been found in rocks of practically every geological period.

Conditions favorable for the presence of oil or gas are a porous stratum and an impervious cover, thus making possible the formation of a subterranean reservoir. It is found in sands or coarse sandstone, as well as in cavities of limestone. The impervious



TYPICAL OIL BEARING FORMATION
Showing well drilled into oil deposit on slope of anticline

overlying stratum is necessary to protect the oil from water and air.

There also are structural conditions necessary to the presence of oil and gas. The largest deposits have been found in strata unbroken and comparatively undisturbed through the ages. The presence of anticlines, which are upward folds or raises in the strata of the earth's surface, exert a powerful influence.

These anticlines may be sharply defined and limited in area, or may have a gradually upward rise and extend over a great area. They frequently are in series, and sometimes are crossed by subsidiary anticlines; all of which play an important part in the accumulation of oil. The dip of the anticline may be very gradual—sometimes only a few feet to the mile.

It is in identifying these anticlines and observing other indications that the work of a geologist plays such an important part in the oil fields.

The downward fold or trough (the opposite of the anticline) is called a syncline—and, of course, is not favorable to the accumulation of petroleum.

A visitor to the Duke pool in the Ranger territory tells of three wells drilled in a row 200 feet apart in the heart of the pool. The two end wells were prolific producers of oil and were giving forth very little gas, while the well in the middle was "gassing" copiously and producing oil in very small quantity. The explanation was that the middle well had been drilled at the very crest of the anticlinal wave.

In the sand at the highest elevation in the anticline is found gas, which, because of its lightness, rises above the oil. Next in order down the slope of the anticline is found the petroleum. Water, being heavier than the oil, is found toward the base of the anticline and in the trough of the syncline. The drilling for oil, therefore, is along the slope of the anticline. It requires drilling, however, to determine whether the structure is productive or barren of oil.

The anticlines in the Gulf Coast field are of a sharp pitch and are called domes. Some of these domes are very limited in extent and the oil is found in some cases closely associated with sulphur and rock salt deposits; hence the term "salt dome." The produc-

tive area at Spindletop was found to embrace only about 300 acres.

So sharp is the structural incline in this territory that unproductive wells not infrequently are completed a very short distance from highly productive wells. Because of this fact, operations in this field are regarded as more hazardous than in the average oil territory.

But, as if to make amends for this situation, some of the greatest "gushers" in the history of American oil development have been struck in the Gulf Coast district. The Lucas well had an initial flow of close to 100,000 barrels a day. Many other wells have produced from 10,000 to 50,000 barrels daily. The Gulf Coast oil is of an asphalt base not high in gasoline content, but admirably adapted to fuel oil production.

The geographical distribution of petroleum is not limited to any part of the world, although the prolific fields thus far discovered are for the most part north of the equator. The relative importance of the various countries as oil producers is most graphically indicated by figures compiled by the United States Geological Survey.

This tabulation shows that of the world's total in 1917 of 500,651,086 barrels, there were produced and marketed from the fields of the United States 335,315,601 barrels, or almost 67%. Russia stood in second place, with 69,000,000 barrels, or slightly less than 14%. Mexico was third, with 55,292,770 barrels, or 11%. It is generally conceded, however, that Mexico went into second place in 1918. The 1917 output of the United States and Mexico amounted to 78%, or almost four-fifths of the world's total.

The standing of other countries as petroleum producers in 1917 follows: Dutch East Indies, 12,928,955 barrels, or 2.58%; India, 8,500,000 barrels, or 1.70%; Galicia, 5,965,-447 barrels, or 1.19%. Japan and Formosa, 2,898,654 barrels, or .58%; Rumania, 2,681,-870 barrels, or .54%; Peru, 2,533,417 barrels, or .51%; Trinidad, 1,599,455 barrels, or .32%; Argentina, 1,144,737, or .23%; Egypt, 1,008,750, or .20%; Germany, 995,764 barrels, or .20%; Canada, 205,332 barrels, or .04%. Italy is credited with 50,334 barrels and all other countries, including Cuba with 16,167 barrels, with a total of 530,000 barrels. The percentage for Italy and the other

countries was .11. The figure for the Dutch East Indies includes British Borneo.

A small amount of oil is being produced in Cuba. Santo Domingo is said to show promise. Development work has been going on in Persia. Mespotamia is said to give indications of developing an oil field. Exploratory drilling is being conducted in England. Wells have been completed in Colombia, South America, but marketing facilities have not yet been provided. Venezuela has been found to be productive of oil, the output of some of its wells being refined at a plant on the neighboring island of Curacao.

Wells are being drilled in Costa Rica and Panama in the hope of finding supplies of fuel oil convenient to the Panama Canal. Oil companies also have been granted concessions in the republics of Guatemala and Honduras. Ecuador and Bolivia are said to contain oil indications, which also have been noted along the eastern slope of the Andes in the Amazon basin.

Mexico, with its immense "gusher" wells has a potential production very greatly in excess of the 63,000,000 barrels credited to it in 1918. At present it is regarded as the world's

greatest future source of heavy oils suitable for fuel purposes. Latin America apparently is destined to be the scene of intensive exploration and development in the next decade.

In the United States some fifteen states in widely scattered sections have entered definitely the ranks of oil producers. They are Oklahoma, Kansas, Texas, Louisiana, California, Wyoming, Montana, Colorado, New York, Pennsylvania, West Virginia, Kentucky, Ohio, Indiana and Illinois. Of these states New York, Montana and Colorado do not produce large quantities of oil. Small wells have been drilled in Alaska, Michigan and Tennessee.

Test wells are being put down continuously in other states and new sections of states already in the producing column. Undoubtedly this work will result, as in the past, in extending largely the producing areas.

These states are grouped for convenience into fields. The Appalachian field, for instance, includes Pennsylvania, West Virginia, Kentucky and adjacent producing territory in New York and Ohio. The Mid-Continent field includes Oklahoma, Kansas, Northern Texas and Northern Louisiana. The Gulf Coast field includes the territory

in the coastal plain of Louisiana and Texas. The Lima-Indiana field embraces northwestern Ohio and Northeastern Indiana. The Illinois field includes the producing section of that state and adjacent territory in Western Indiana. California constitutes a field in itself. The Rocky Mountain field includes Wyoming, Montana and Colorado.

The following table shows the field classification used by the United States Geological Survey and production figures indicating the relative importance of the territories in 1917 and 1918:

MARKETED OUTPUT OF THE FIELDS OF THE UNITED STATES IN 1917 AND 1918 IN BARRELS OF 42 GALLONS EACH.

Field.	1917	1918
Appalachian	24,932,205	25,300,000
Lima—Indiana	3,670,293	3,100,000
Illinois	15,776,860	13,300,000
Oklahoma—Kansas	155,043,596	139,600,000
Central and North Texas	10,900,646	15,600,000
North Louisiana	8,561,963	13,000,000
Gulf Coast	26,087,587	21,700,000
Rocky Mountain	9,199,310	12,600,000
California	93,877,549	101,300,000
Alaska and Michigan	10,300	
	335,315,601	345,500,000

IV

HISTORY OF OIL DEVELOPMENT

FOUR and one-half billion barrels of petroleum! That is the record of the United States from the inception of the industry in 1857 up to the end of 1918.

The world's production of the 61 years ending with 1917 was 6,983,567,246 barrels, of which the United States produced 4,252,644,003 barrels of 42 gallons each, or almost 61%.

The country's marketed production in 1918 is estimated at 345,500,000 barrels. This means that of the United States total for 62 years (1857 to 1918, inclusive) 8% was produced in 1918. All of which gives an insight into the present gigantic proportions of the industry.

That the history of petroleum in the United States means world petroleum history is proved by the fact that the United States in 1917 gave forth 67% of the world's total, the nearest competitor, Russia, contributed

slightly less than 14%. Next came Mexico, with 11%. No other country approached any of these percentages, the Dutch East Indies being fourth with $2\frac{1}{2}$%.

Most of Mexico's output is produced by American companies and is sent to the United States to be refined and marketed. The United States and Mexico, which, therefore, may be considered practically as a unit, were responsible for 78% of the world's supply of petroleum. It is essentially an American industry.

Although the real history of petroleum began to be written only a little more than a half-century ago, "rock oil" was gathered for various ritual uses in remote ages, and later for medicinal purposes. The word itself is derived from the Latin words,—"petra," meaning rock, and "oleum," meaning oil—rock oil.

Herodotus described in his writings oil pits near ancient Babylon and pitch springs near Zante. Mention also is made by early historians of oil obtained near Agrigentum in Sicily and used for illuminating purposes. Ancient records of China and Japan contain allusions to the use of natural gas, while pe-

tro'eum or "burning water," was known in Japan in the seventh century.

The gas springs of North Italy led to the adoption in 1226 by the municipality of Salso-maggiore of a salamander surrounded by flames as its emblem. Marco Polo in the thirteenth century referred to the oil springs of Baku.

Probably the earliest mention of petroleum in the western hemisphere occurs in Sir Walter Raleigh's references in 1595 to the pitch lakes of Trinidad. Thirty-seven years later Joseph de la Rochelle d'Allion referred to the oil springs of New York as published in Sagard's "l'Histoire du Canada."

A Russian traveler, Peter Salm, in a book on America published in 1748 showed a map of the oil springs of Pennsylvania and about the same time Racievitch referred to the deposits of liquid bitumen in Rumania.

Although the Drake well, which was completed in the Oil Creek district of Pennsylvania in August, 1859, was not the first in America actually to produce oil, it is generally conceded to have been the first well drilled with the deliberate intention of obtaining oil.

Wells drilled prior to this pioneer of pioneers were for the purpose of producing salt water, and the presence of petroleum was looked upon as little less than a calamity—it complicated almost to the point of hopelessness the process of manufacturing salt! To-day salt water is the bugaboo of the oil man.

Long before the first white settler penetrated the territory, the presence of oil in certain parts of Pennsylvania and New York was known to the Indians and they made use of it for medical purposes. It was known to the first white men who learned of its existence as Seneca oil—it having been the Seneca Indians whom they found making use of the product.

It even is believed that use of this mineral oil by the American aborigines extended over several centuries before the white men came. There were noticeable in the early days of Pennsylvania's oil development many oblong pits in the oil seepage sections of Venango and Warren counties. It is possible that some traces of these old pits still exist. They were dug in the low ground near streams and undoubtedly were constructed with a view to

collecting petroleum. In some cases they were thickly scattered over areas several hundred acres in extent.

Some idea as to their antiquity may be gained from the assertion that a tree growing in the bottom of one of these pits was felled in 1815, and it showed rings of growth indicating that it was eighty years old.

The Rev. S. J. M. Eaton's "History of the Oil Regions," published in 1865, tells of hundreds of trees showing a diameter of one and one-half feet growing in the petroleum pits, "indicating an antiquity antedating the earliest records of civilized life in this region."

At least two American oil springs are mentioned in writings of explorers a century and a half ago. Mention also was made of oil floating on the surface of Oil Creek.

"In the northern part of Pennsylvania," says a letter written by Gen. Benjamin Lincoln in 1773, "there is a creek called Oil Creek, which empties itself into the Allegheny River, issuing from a spring on the top of which floats an oil, similar to what is called Barbadoes tar, and from which may be collected by one man several gallons in a day.

"The troops in marching that way halted

at the spring, collected the oil and bathed their joints with it. This gave them great relief, and freed them immediately from rheumatic complaints with which many of them were affected. The troops drank freely of the waters—they operate as a gentle purge."

"I have seen three kinds of oil springs—such as have an outlet, such as have none, and such as rise from the bottom of the creek," wrote David Leisberger, a Moravian missionary, in a report on his visit to the Allegheny regions in 1767. "From the first, water and oil flow out together, the oil impregnating the grass and soil; in the second it gathers on the surface of the water to the depth of the thickness of a finger; from the third it rises to the surface and flows with the current of the creek.

"The Indians prefer wells without an outlet. From such they first dip the oil that has accumulated; then stir the well, and when the water has settled, fill their kettles with fresh oil, which they purify by boiling. It is used medicinally, as an ointment for toothache, headache, swellings, rheumatism and sprains. Sometimes it is

taken internally. It is of a brown color and can also be used in lamps. It burns well."

"The virtues of Seneca oil are similar to those of British oil and supposed to be equally valuable in the cure of rheumatic and other pains," wrote F. Cuming after a tour of the territory in the summer of 1807, "large quantities being collected in Oil Creek, a branch of the Allegheny River, and sold at from one dollar and a half to two dollars per gallon.

"The mode of collecting it is this: The place where it is found bubbling up in the creek is surrounded by a wall or dam to a narrow compass. A man then takes a blanket, flannel or other woolen cloth, to which the oil adheres, and spreading it over the surface of the enclosed pond, presses it down a little, then draws it up, squeezes out the oil into a vessel prepared for the purpose; thus twenty or thirty gallons of pure oil can be obtained in two or three days by one man."

The foregoing is enlightening in contrast with the present, both as to petroleum prices and as to production methods. On a basis of the prices mentioned, a 42-gallon barrel of oil was marketable at from $63 to $84—providing anyone could have been found who

would have been willing to purchase such an unheard-of quantity. The use of oil at that time, it must be remembered, was confined to the range already mentioned.

A single producing well the size of those that are common to-day would have wrought panic a century ago. Not only would it have defied efforts to care for it as it emerged from the earth, but, had it been possible to save it, the oil as to marketability would have proved a white elephant to the producer.

The entire early history of the oil industry was fraught with a never-ceasing struggle to find new uses for petroleum and thereby keep the demand somewhere near the possibilities of production. Occasionally, it is true, high market levels were reached in the years immediately following the drilling of the Drake well, but these usually were the result of manipulation.

The woolen blanket method of collecting oil prevailed, it appears, for many years. The following extract from the writings of the Rev. Mr. Eaton describes the production method practiced probably between 1810 and 1815:

"A point was selected where the oil ap-

peared to bubble up most freely, when a pit was excavated to a depth of two or three feet. Sometimes this pit was rudely walled up, sometimes not. Sometimes it was near the edge of the water on the bank of the stream, sometimes in the bed of the stream itself, advantage being taken of a time of low water.

"In these pits the oil and water would collect together, until a stratum of the former would form upon the surface of the latter, when a coarse blanket or piece of flannel was thrown in. This blanket soon became saturated with oil, but rejected the water. The blanket was then taken out, wrung into a tub or barrel and the operation repeated."

"The first shipment of petroleum was to Pittsburgh," wrote the same authority concerning the early marketing of Pennsylvania oil, "and was in this wise: Mr. Cary, one of the first settlers on Oil Creek, possessing perhaps a little more enterprise than his neighbors, would collect or purchase a cargo of oil and proceed to Pittsburg and exchange it for commodities needed in his family. This cargo consisted of two five-gallon kegs, that were slung one on each side of a horse, and

thus conveyed by land a distance of seventy or eighty miles.

"Sometimes the market in Pittsburg became very dull, for a flatboatman would occasionally introduce a barrel or two at once that he had brought down on his raft of lumber or logs. At other times the demand fell off so that the purchase of a barrel was hazardous.

"At a period somewhat later than this, General Samuel Hays, who settled here in 1803, related that at one time he purchased all the oil produced in the country, and that the highest annual yield was sixteen barrels. This oil he sold at the time in Pittsburgh at about $1 per gallon."

It appears that it was not until the second quarter of the last century, however, that activity began to manifest itself in the direction of developing a broader field of usefulness for petroleum. The following letter appeared in the Pittsburgh Gazette in 1828:

"I see that the corporation has at last determined to light the city. It is a very sensible determination; for, indeed, few places need it more. I fear that lighting with gas will be found troublesome and expensive, in

spite of the vast supply and cheapness of coal; but I will tell you what is the cheapest, best and most economical light you can use; it is what is called the West Seneca oil, which is petroleum.

"This substance, were there a ready market for it, might be supplied at your very doors to an almost unlimited extent. At present it is almost useless, being used only as an ingredient in what is called 'British Oil,' and as a horse medicine (in which, by the way, it is very useful). The price of it is very low, because a few barrels glut the demands of the apothecaries; but if the city would take a large supply, or if it were brought into use otherwise, I think it could be supplied at 25 cents per gallon. The salt well may be cleared of what floats by letting a blanket down every quarter of an hour, and this will also apply to the springs where it is discovered.

"Let anyone who doubts that it is a perfectly good oil for lamps send to the apothecary's for half a pint, and burn it one night in a lamp of any kind, precisely as fish or spermaceti oils are burned, observing only that to avoid smoke, it is necessary that the

length of the wick should be diminished. I have tried it, and found it to succeed perfectly, and there is no reason why it should not be clarified as well as any other oil (and then it will burn as free from smoke) by filtering or precipitating the gross particles contained in what is now brought to market.

"If Seneca oil will supply more gas than animal oils, which I do not doubt, and if it can be procured at 25 cents per gallon, a fair trial of it in this way would assuredly be demanded by common prudence."

Oil coming from a salt well at Tarentum in Allegheny County began to give its owner, Samuel M. Kier, considerable difficulty about 1849. He accumulated a large quantity of oil, but could find no market for it. His efforts even led to the erection of a small, but unsuccessful refinery in Pittsburg. This refinery, however, did begin to achieve some degree of success about 1860.

Mr. Kier finally began to bottle the oil and placed it on the market from the angle of its curative properties. One of his circulars bore the date January 1, 1852.

This effort of Mr. Kier to obtain a market for his oil resulted finally in the drilling of the

Drake well—the first in the United States with petroleum as its purpose. It happened that about this time George H. Bissell of New York became interested in the possibilities of "rock oil." After obtaining a tract of 105 acres of land in Cherrytree Township, Venango County, Pennsylvania, for $5,000, Mr. Bissell and associates December 30, 1854, incorporated under the laws of New York the Pennsylvania Rock Oil Company, with capital of $250,000.

Other Eastern capitalists about the same time became convinced that it would be profitable to produce oil. They, however, were unwilling to subscribe to the stock of a company incorporated under the laws of New York. Consequently the Pennsylvania Rock Oil Company on September 18, 1855, was incorporated under the laws of Connecticut with a capital of $300,000.

This first company formed to produce oil in the Pennsylvania fields intended at the time of organization to obtain its product by ditching and developing the surface of the property. Little was accomplished in the first year or two because of a lack of harmony among the stockholders, and in 1856

Mr. Bissell read one of the Kier circulars stating that the oil which he was selling was obtained from a depth of 400 feet under the earth's surface. This was the genesis of the Drake well.

Mr. Bissell consulted with J. G. Eveleth, who had been his harmonious associate since they purchased the land. Mr. Eveleth favored the plan, but the two men were not in a position to finance it. The proposition was placed before a Mr. Havens of New York, who indicated his attitude by offering them $500 if they would obtain from the Pennsylvania Rock Oil Company a lease on the property. This finally was obtained, the terms being that Havens was to commence operations within a year and pay 12 cents a gallon royalty on all oil produced in fifteen years.

Mr. Havens did not comply with the terms of his lease, so the capitalists who went into the company when the stock was increased to $300,000, acting against the wishes of the other directors, made a lease to E. E. Bowditch and E. L. Drake at a royalty of 5½ cents a gallon. This lease, however, soon was supplemented by another making the royalty 12

cents and the lease for a period of 45 years. It was with this lease as a basis that the Seneca Oil Company was formed March 23, 1858.

Mr. Drake, who was superintendent for the Seneca Oil Company, reached Titusville in May, 1858, and immediately began a search for someone to drill the well. From the ditches he gathered a small quantity of oil, but his principal attention was directed to the well proposition.

Failing to dig a well to solid rock, he began the construction of a drill house, ordered an engine and completed arrangements with a driller. Although he had expected to commence drilling operations in September, the failure of the engine to arrive and the fact that sufficient funds were not forthcoming caused the work to be postponed for the winter.

In the spring the driller he engaged failed to appear, so Drake finally employed "Uncle Billy" Smith, who, with his two sons, reached Titusville about the middle of June. It already having been found impossible to dig down to bed rock, Drake conceived the idea of driving a pipe down through the soil.

This was done and bed rock was found at a depth of 36 feet. Drilling then was begun.

The drill was started in May and oil was struck on the afternoon of August 28, 1859, at a depth of 69½ feet. The oil rose to within ten feet of the surface. The well then was equipped with a pump and is said to have produced 40 barrels a day for a short time. By the end of the year it was producing only about 15 barrels a day. This oil found a ready sale at 50 cents a gallon.

What is believed to have been the second well drilled in the Oil Creek district was on the Buchanan farm near Rouseville. This well was drilled into the first sand by Rouse and Mitchell in December, 1859. Eight barrels a day were pumped from it for some time, and it then was drilled to the third sand and produced 300 barrels a day. Afterwards, however, it was abandoned, to be purchased in 1871 by Gould and Stowell. The new owners cleaned it out and it began to produce again.

In the meantime other companies had been formed, both for extracting oil out of coal and for drilling into the oil sand. Production of oil from all sources in the Pennsyl-

vania region in 1859 has been estimated at 8,500 barrels, this figure also including that from the oil springs in the neighborhood of Cuba, N. Y. The 1859 production of the Drake well was estimated at approximately 2,000 barrels.

Oil-development operations were pushed in 1860 in the lowlands along Oil creek, French creek and the Allegheny river, oil being found at Tidioute, Henry's Bend, Franklin and Smith's Ferry. The building of two refineries was begun at Erie. Pittsburgh, however, in that year formed the principal market, which was reached by boats and teams. It was not until 1856 or 1866 that the advantage of pipe line transportation began to be realized.

The first "gushers" were completed in 1861. The first was on Oil creek near Rouseville. Several of these flowing wells spouted at the rate of 2,000 to 2,500 barrels a day, the oil flooding the territory adjacent to the wells. Oil could be purchased as low as 5 cents a barrel.

It was on April 17, 1861, that there occurred at the Little and Merrick well on the Buchanan farm the first great tragedy of the

© Brown Bros N.Y.

Scene at Oil City
Center of Pennsylvania fields

oil fields. A crowd had been attracted to the well, which was flowing about 3,000 barrels a day, when an explosion occurred, the oil burst into flames and 19 persons were burned to death, 11 others being terribly injured.

Until 1864 developments were confined to the localities already mentioned, but in that year the Oil Creek operations were extended up Cherry Run, and there was a great deal of excitement in all parts of the country.

The next year, 1865, which saw the collapse of many speculative oil propositions, witnessed the discovery of the Pithole pool. Wells also were brought in in various other localities. Clarion county began to attract attention in 1866, and in that year a railroad was built into Venango county. A small well was struck near Bradford in 1868. It is estimated that in 1869 there were 1,186 producing wells. Butler, Armstrong and Clarion counties and Church Run, near Titusville, were the centers of activity.

Butler and Clarion counties produced numerous "gushers" in 1872, with a consequent decline in values in spite of numerous ingenious schemes on the part of producers to maintain prices. What is known as the

Butler and Armstrong cross belt was discovered in 1874, production being far in excess of the market demand. Warren county became an oil country in 1875.

The Allegheny field reached its height in 1882, while 1883 saw the development of the Balltown and Cooper pools in Forest county. Washington county was added to the list in 1885, Greene county following shortly. McKean and Elk counties then became producing territory.

As the state's production approached the maximum, prices in 1887 went down to an alarmingly low figure. From 1871 to 1878 annual production is estimated to have averaged about 10,000,000 barrels, while the region from 1879 to 1886 showed an average of 25,000,000 barrels. Among the districts discovered in 1888 were Canonsburg, Murdocksville, Nineveh and Crafton, the Bradford and Allegheny fields beginning to decline.

The high point of production for the Pennsylvania-New York territory was reached in 1891, with 33,009,236 barrels.

The year opened with the price of oil around 75c. a barrel, and closed at about 60c. The

value of the production, therefore, was in the neighborhood of $22,000,000.

The entire Appalachian field, exclusive of Kentucky, produced in 1917 slightly less than 25,000,000 barrels, but, with an average price of more than $3 a barrel, the value was approximately $75,000,000 or more than three times the 1891 Pennsylvania-New York figure.

Sistersville forged to the front in 1892, while the Brownsdale pool in Butler county began to attract attention in the following year. Numerous pools were opened up in the next few years, and the limits of the older ones extended.

Nothing approaching a sensation developed in Pennsylvania until 1911, when a 900-barrel was drilled in Green county. This, however, showed a rapid decline in production. In the meantime the annual output had declined steadily. Southwest Pennsylvania supplied two new pools in 1914, one at Evans City in Butler county and the other in Indiana township, Allegheny county. In the first pool, the initial well was a 200-barrel producer drilled on the Lutheran Church lot in the town of Evans City.

From Pennsylvania and New York the oil-producing territory of the East was extended to Ohio, West Virginia, Kentucky and Indiana. California and the Gulf Coast fields were added. Then a field was opened on the Indiana-Illinois line. Shortly after that the interest of the oil producers began to turn to the Mid-Continent field, the greatest present producing section of the United States.

From the Oklahoma and Kansas fields of the Mid-Continent territory, the producers in 1918 and 1919 made a rush to North Central Texas, known as the Ranger district and which is an extension to the Mid-Continent field.

This gives promise of becoming one of the most prolific producing territories in the history of oil development. In the meantime the fields of Mexico have been the scene of greater and greater activity, while production in Wyoming also has gained steadily and new pools have been opened in North Louisiana.

The oil development in West Virginia followed closely that of Pennsylvania. Oil was discovered in shallow pits near Parkersburg

just before the Civil War. Approximately 3,000,000 barrels of oil, which are estimated to have been valued at $20,000,000, were taken out of the various districts of West Virginia from 1865 to 1876.

West Virginia was about ten years behind Pennsylvania in attaining the high point of production. Pennsylvania made its record in 1891 with 33,009,236 barrels, while West Virginia attained its record output in 1900, with 16,195,675 barrels.

Since these years the production trend in both states has been gradually downward, although the oil, because of its high gasoline and lubricating oil content, demands the highest market price of any petroleum produced in the country, the value in 1918 having been upward of $75,000,000 for the crude product at the wells.

Drilling in the Lima field of Ohio was started in 1885, although oil had been produced in the eastern section of the state prior to that time. The earlier drilling was an extension of the development of the Pennsylvania and West Virginia fields.

Government reports first place Ohio in the producing ranks in 1876, with 31,763 barrels.

Production in 1884 amounted to 90,081 barrels, advancing in 1885 to 661,580 barrels, in 1886 to 1,782,970 barrels, in 1887 to 5,022,632 barrels and in 1888 to 10,010,868. Ohio's greatest year was 1896, with 23,941,169 barrels. Since that time the decline has been gradual until in 1918 the marketed output of the Lima-Indiana field, which embraces northwestern Ohio and adjacent territory in Indiana, was only 3,100,000 barrels.

Indiana is officially credited with entering the producing ranks in 1889, with 33,375 barrels, although scattered wells of small production had been drilled prior to that time. Indiana's high point was in 1904, with 11,339,124 barrels.

Illinois is said to have been the scene of oil drilling about the time of the oil rush in Pennsylvania. This work, which is reported to have resulted in small showings of oil, was in Clark county, a few miles north of Casey, which, many years later, became the center of a vigorous and profitable development, oil being found at comparatively shallow depths.

Production of 1,460 barrels was credited to Illinois in 1889. This had dropped by 1902 to 200 barrels, while no production was

reported in 1903 or 1904. Thereafter the Illinois "boom" started, a 35-barrel well being completed near the old tests in Clark county. The state's output in 1905 was 181,084 barrels, being increased in 1906 to 4,397,050. Production in 1907 leaped to 24,281,973 and in the following year attained its high point of 33,686,238 barrels. The state's output in 1918 is estimated at 13,300,000 barrels.

Kentucky, which in 1917, 1918 and 1919 was the scene of the greatest activity east of the Mississippi river has a petroleum history that is crammed with interest. In fact, it is asserted that it was in Kentucky that the first flowing well in the United States was recorded. The well was drilled in the southeast corner of Wayne county in 1818 by David Beatty, but Beatty was not seeking oil; his quest was for salt. At a depth of 170 feet petroleum began coming out of the well with salt water.

The flow attained such volume that oil covered the surface of the water in the Big South Fork of the Cumberland river. The floating oil caught fire and the surface of the river blazed fiercely for a distance of 35 miles to the junction of the fork with Cumberland

river proper. Finally the flow of oil ceased, the fire went out and the well came to be forgotten.

Another salt well was "ruined" by oil in 1829. This well, which was 180 feet deep, was near Burksville in Cumberland county. The flow lasted three or four weeks, the oil in the meantime becoming ignited and providing a repetition of the occurrence of the Beatty well.

The next incident in the development of the Kentucky oil fields is believed to have been in 1865, when C. H. English drilled eight shallow wells along Crocus creek.

One of these wells is reported to have flowed 900 barrels a day, but the wells were abandoned because there were no means of transporting the oil to market.

A well which is reported to have produced 1,000 barrels of high-grade oil in 24 hours was drilled in 1865 at Cloyd's landing, six miles southwest of Burksville. J. W. Sherman, who had gained considerable fame as an operator in the Oil Creek District of Pennsylvania, drilled this well. In order to market some of the oil he loaded a barge with it and started to ship it in bulk to

Nashville, Tenn. The barge, however, was wrecked. The oil excitement in Pennsylvania was at a high stage and Sherman returned to that state.

Clinton county, which lies between Wayne and Cumberland, also was one of the pioneer Kentucky oil counties. A salt water well drilled about 1827 produced oil.

It is related that in 1864 L. D. Carter of Aurora, Ill., saw the well and, believing that the oil would prove an excellent lubricant, obtained a small quantity of it and submitted it to a railroad company for a test. The result was that the railroad company agreed to purchase the oil and Carter for several years delivered six or eight barrels of the oil a day in wagons, hauling it to the Cumberland river.

This Clinton county well again attracted attention in 1892, when J. Hovey cleaned it out and made it a profitable producer. He also drilled three other wells, one of which is reported to have produced 2,400 barrels of heavy oil in two months. The wells, however, eventually were shut down because of lack of storage facilities and transportation.

The Hovey property and other holdings in that territory were acquired about 1897 by the Standard Oil Company. This company also drilled in Wayne county, opening what was known as the Slick Fork pool.

Another early spectacular oil development occurred in Lincoln county in 1839. A well drilled for salt water a few miles from Stanford struck oil, the petroleum catching fire and burning for several weeks.

Barren county became the scene of oil activity in 1861, the first well being drilled three miles south of Glasgow. It produced some oil, and other wells were drilled. Four shallow wells were drilled along Green river about 12 miles south, one of which flowed for a while at the rate of 400 barrels a day.

From the early days of the settlement of the country in the northeastern section of Kentucky, it is related that petroleum was obtained for medicinal purposes from the surface of streams. This was in Boyd, Carter, Greenup, Johnson and Lawrence counties.

The absence of a market for oil resulted in the halting of development shortly after the drilling of a well in 1860 eight miles above

Paintville. This well at a depth of 250 feet found a heavy oil, but the production of the well was not ascertained. An aggressive development along Paint creek was carried out in 1864 and 1865, several hundred shallow wells being drilled—but Pennsylvania so overshadowed this development that the operators were compelled to withdraw until more favorable conditions accompanied their efforts.

To the south in Tennessee, numerous wells are reported to have been drilled in 1894 and 1895 along Spring creek. An oil lighter both in color and gravity than the Kentucky product was obtained. It is only just now, however, that a serious effort is being made to develop it.

The United States Geological Survey has kept the production figures for Kentucky and Tennessee together. The Tennessee production, however, has been so small that the figures for all practical purposes may be regarded as Kentucky's output.

The Government statisticians first recognized the field in 1883, when the two states were credited with an output of 4,755 barrels. Only a gradual gain was shown until 1891,

when an output of 9,000 barrels was attained. The following year, however, showed a slump to 6,500 barrels and the amount in 1893 dropped to 3,000 barrels. It dwindled gradually then until 1897, when the two states were credited with a production of only 322 barrels. In 1898, however, the amount had increased to 5,568 barrels.

Thereafter the increase was rapid until 1905, when the amount first crossed the 1,000,000-barrel mark. The 1905 total was 1,217,337 barrels. Practically the same amount was produced in 1906. Then in 1907 it dropped to 820,844 barrels. From that year until 1916 the Geological Survey credits no production to Tennessee.

The output dropped gradually until it had receded to 468,774 barrels in 1910. Then it began to gain gradually until another high point of 524,568 barrels was recorded in 1913. By 1915, however, it had fallen to 437,274 barrels.

But, to indicate the suddenness with which Kentucky and Tennessee are attaining prominence in the petroleum world, one has but to consider the figures for 1916, when the two states are credited by the Geological

Survey with an output of 1,203,246 barrels, almost three times the 1915 output.

C. R. Dulin, now of Lexington, Ky., is largely responsible for this showing. It was he who in May, 1914, drilled a well in the Irvine field of Estill county, Kentucky. The well, although it had a production of only about five barrels a day, started a development that has resulted in hundreds of wells being drilled and several thousand barrels a day of oil being developed.

It was not until 1915 and 1916 that the real Kentucky development began. At last reports there were recognized producing areas in 18 counties and showings reported in at least 25 other counties.

The monthly quantity of oil being taken from the wells was reported in the spring of 1919 to be closely approaching 700,000 barrels, which indicates that Kentucky's output is growing steadily. In fact, the Kentucky State Geologist in the early summer of 1919 estimated that the state's output in that year would reach 7,500,000 barrels, valued at approximately $19,500,000.

Neglected and overlooked in the growth of the oil industry westward, Kentucky, with

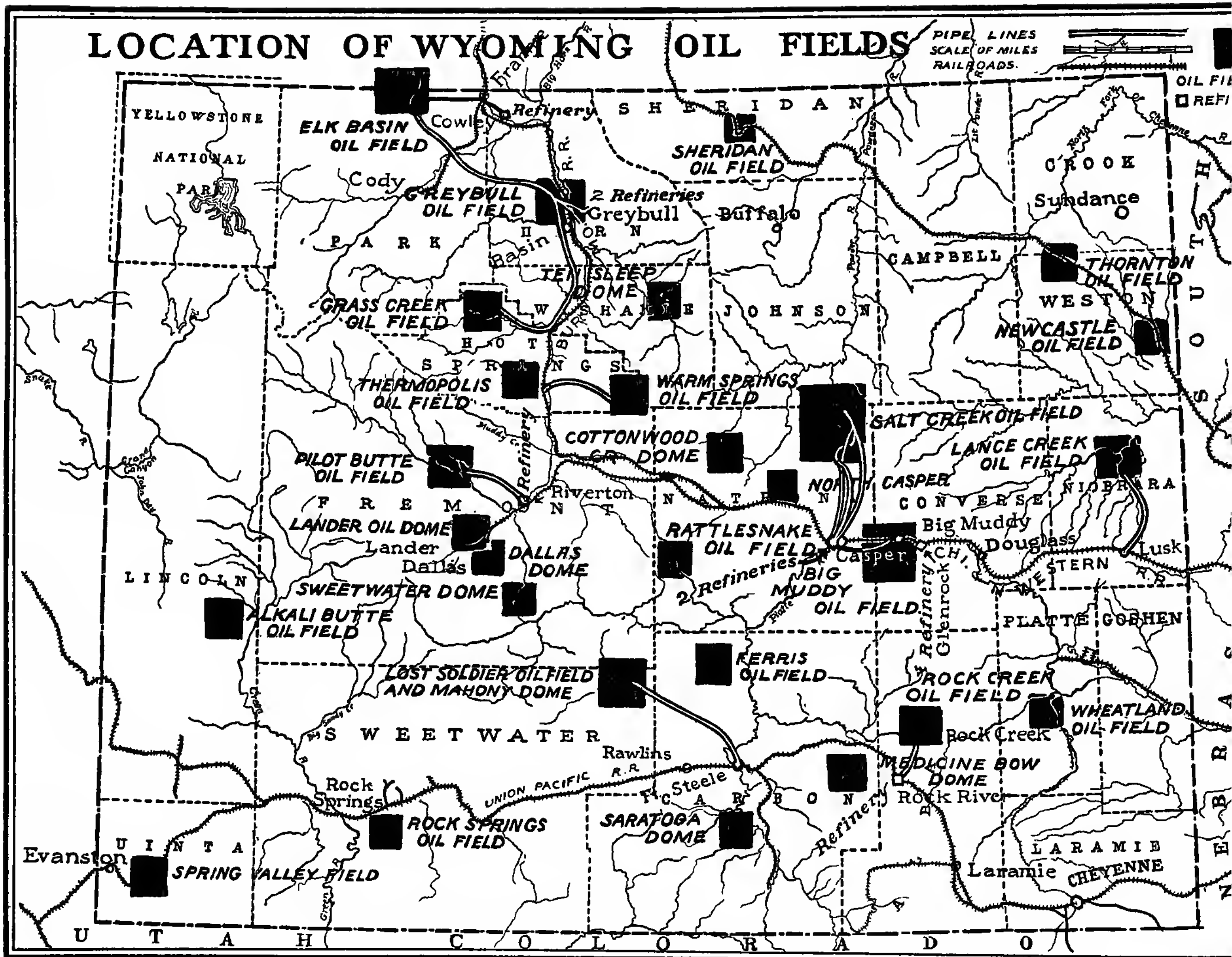
its shallow and comparatively inexpensive wells and interesting history, apparently is coming into its own as never before.

Wyoming is another territory that, with oil indications reported as early as 1849, just now is entering the serious phase of its oil development. Already numerous fields have been opened and the year 1919 saw many new territories being opened and pipe lines being laid to provide a market for the production.

A writer who visited the state in 1849 chronicled that at what now is Hilliard, Uinta county, "a spring of petroleum or mineral tar oozes from the low bank of a little rivulet flowing into the valley of Sulphur creek." The oil, it was said, was collected by the emigrants—for medicinal purposes and for greasing their wagon wheels. About the same time, according to State Geologist Trumbull, the Carter oil spring, six miles to the west, was discovered.

It is stated that as early as 1863 oil was collected from a spring near Poison Spider creek and sold to emigrants passing over the old Morgan Trail. At that time the sales were limited to the demand for wagon grease.

In 1883, however, a new use was found for


LOCATION OF WYOMING OIL FIELDS
PIPE LINES
SCALE OF MILES
RAILROADS.
YELLOWSTONE NATIONAL PARK
ELK BASIN OIL FIELD
Cowley
Refinery
SHERIDAN
SHERIDAN OIL FIELD
CROOK
Sundance
Cody
GREYBULL OIL FIELD
2 Refineries
Greybull
Buffalo
PARK
Basin
CAMPBELL
THORNTON OIL FIELD
WESTON
TEN SLEEP DOME
GRASS CREEK OIL FIELD
JOHNSON
NEWCASTLE OIL FIELD
HOT SPRINGS
THERMOPOLIS OIL FIELD
WARM SPRINGS OIL FIELD
SALT CREEK OIL FIELD
LANCE CREEK OIL FIELD
COTTONWOOD CR. DOME
PILOT BUTTE OIL FIELD
Refinery
Riverton
NORTH CASPER
CONVERSE
NIOBRARA
FREMONT
NATRONA
LANDER OIL DOME
Lander
Dallas
DALLAS DOME
RATTLESNAKE OIL FIELD
Casper
Big Muddy
Douglass
Lusk
SWEETWATER DOME
2 Refineries
BIG MUDDY OIL FIELD
Glenrock
LINCOLN
ALKALI BUTTE OIL FIELD
PLATTE
GOSHEN
FERRIS OIL FIELD
LOST SOLDIER OIL FIELD AND MAHONY DOME
ROCK CREEK OIL FIELD
WHEATLAND OIL FIELD
Rock Creek
SWEETWATER
Rawlins
MEDICINE BOW DOME
Rock Springs
UNION PACIFIC R.R.
Ft. Steele
CARBON
Rock River
ROCK SPRINGS OIL FIELD
SARATOGA DOME
Evanston
UINTA
SPRING VALLEY FIELD
LARAMIE
Laramie
CHEYENNE
UTAH
COLORADO

the product. The ranchers in the Big Horn basin ran short of lamp oil and substituted crude oil gathered from a spring near Bonanza creek.

The first well drilled in Wyoming from which production was marketed, says Mr. Trumbull, was the Carter well in Uinta county. The first "gusher," according to the State Geologist, was drilled in the Dallas field in 1883, while the first wells at Shannon in the north end of the now famous Salt Creek field date from 1889.

Production from the wells at Shannon, after the building at Casper in 1895 of a 50-barrel refinery, was hauled to that town in wagons drawn by sixteen mules.

The Salt Creek field proper was not drilled until 1908. The first well on this dome is said to have been located by an Italian geologist at the roadside where it had been passed for a score of years by oil men, prospectors and even other petroleum geologists.

For more than a dozen years oil from the Shannon wells had been hauled along this very road on its way to Casper—hauled across what now is the largest and one of the most productive oil fields in the state!

Of the light oil fields in Wyoming, Mr. Trumbull in 1917 listed nine as producers. They were Spring Valley, Salt Creek, Grass Creek, the Torchlight field at Basin, Greybull, Byron, Big Muddy, Elk Basin and Pilot Butte. Since that time other fields have been developed, the Lance Creek and Rock Creek districts in 1919 being the most active in the state. Vigorous development work also was being conducted in the Lost Soldier and other districts.

"In several of the fields there is more than one productive sand," explains Mr. Trumbull in his bulletin. "Grass Creek, for instance, is producing from five, or possibly, seven, different sands."

Recent investigation of the oil sands that underlie the Salt Creek field is reported to have developed the fact that there are four Wall Creek sands instead of two of these strata. Two Wall Creek sands have been found productive in the Big Muddy field.

The Wall Creek sands are regarded as the most productive in the territory. The first Wall Creek sand underlying the Salt Creek dome is encountered at a depth of 1,200 to 1,400 feet. This sand is said to be approx-

imately 110 feet thick. Below this about 300 feet is the second Wall Creek, which in 1918 produced the largest well ever completed in Wyoming. The initial flow was estimated at from 8,000 to 10,000 and as high as 15,000 barrels a day. Each of the lower sands is also believed to be richly impregnated with oil.

Wells in the Wall Creek sand have a relatively high initial yield, which is maintained at a substantial figure over a long period. The first Wall Creek sand in the Big Muddy field is reported to have been found to have a depth of 200 feet, with a high saturation of oil from top to bottom.

Government reports first list Wyoming as a producer in 1894, with 2,369 barrels. This had increased by 1911, including also Utah's output, to 186,695 barrels. The Wyoming production leaped in 1912 to 1,572,306 and since that time the expansion has been steady until the district in 1918 is estimated by the United States Geological Survey to have produced 12,600,000 barrels. The refineries of Wyoming and Colorado in 1918 handled 11,913,125 barrels of crude oil, as compared with 8,834,689 in 1917, a gain of 35%. Ap-

parently Wyoming's oil development still is far from its peak.

Both asphalt and paraffin base oils are found in Wyoming, some of the light oils being extremely high in gasoline and lubricating content. In the crude from the Elk Basin field, for instance, the gasoline content is put at upward of 40%. The asphalt oils usually are subjected to "skimming" and the remainder sold as fuel oil.

V

CALIFORNIA, GULF COAST AND MEXICO

THREE territories that produce petroleum of an asphalt base and upon which apparently will fall the tremendous burden of the future demand for fuel oil are California, the Gulf Coast territory of the United States and the fields of Mexico. The gasoline content of these oils is relatively low, but their "steaming value" in competition with coal and the many advantages they have over coal, makes them loom large both as to present and future importance.

The first discovery of petroleum in California is reported to have been made in Santa Barbara county in 1860 by sheepherders who had taken their flocks there to graze. Attempts also are said to have been made to produce oil in Ventura and Humboldt counties in 1864 and 1865. These efforts apparently were not fruitful.

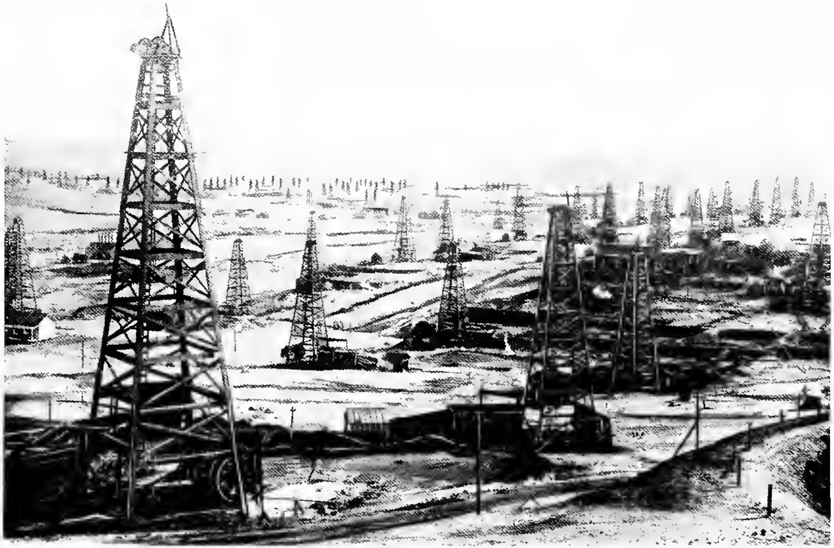
It was in 1865, according to the Standard Oil Bulletin published by the Standard Oil

Company of California, that a Mexican hunter who had followed a deer trail to the head of Pico Canon in Los Angeles county discovered a seepage of a sticky, black fluid. Curiosity prompted him to put a small quantity of it in his canteen and take it to the the San Bernardino mission settlement. It immediately was identified as petroleum by a Dr. Gelsich, who formerly had resided in the oil territory of Pennsylvania. He formed a company at once and staked out claims covering the scene of the discovery.

In 1870 a well was drilled at the head of the canon, the driller being Stanford Lyon. The well is reported to have had initial production of between 70 and 75 barrels a day.

The original well had been drilled by the old spring pole method, and in 1879 a steam engine was taken into the canon and the well drilled deeper. The engine still is on the original location and the well early in 1919 was reported to be producing three barrels a day of 38° gravity oil—among the lightest oils in a state where heavy oils prevail. The field in which the well is located now is known as Newhall.

Subsequent oil development in California



© Brown Bros N Y

One of California's Great Oil Fields

resulted in some of the greatest "gushers" in the country's history, the most notable being known as the Lakeview and Mayes. The greatest California producers were completed largely in 1913. Prior to 1908 California's production was of a heavy fuel oil. Since that time, however, there has been a gradual gain in the output of oils of higher grade.

Early in 1919 a well was completed in new territory at Yorba Linda with initial production of 20,000 barrels a day. This was 23° oil.

The oil pools of California are in the southern part of the state, from Fresno county to the Mexican border. Oil indications, however, are said to have been encountered as far north as San Francisco.

The California fields are located in three general sections, the San Joaquin Valley district, Ventura county and the Coast district. It is estimated that the oil territory in the San Joaquin district embraces about four times the area of the Coast district. In the San Joaquin section are the McKittrick, Kern River, Midway-Sunset, Lost Hills-Belridge and Coalinga fields.

The Coast district, which produces about 20% of the state's output, embraces the Summerland, Santa Clara Valley, Whittier-Fullerton, Los Angeles, Santa Maria and Puente Hill pools.

Oil from the pools in the Coast fields averages a much lighter gravity than that of the San Joaquin Valley district and is used largely for refining, while the San Joaquin oil, which is of a heavy, asphalt base, is mainly used for fuel and road oil. Although most of the California oils are of an asphaltic base, paraffin oil is found in the upper cretaceous formations in the Coalinga district. Geologically the California oil producing territory represents a wide variety of structures.

One of the wonders of the California oil development is at Summerland, where numerous wells have been drilled out in the bay and on the sand of the beach. The derricks in the bay are reached by trestles, which, in some cases, are several hundred feet in length.

The first recorded oil output for California was in 1876, the year's total being 12,000 barrels. The production in 1880 was only 40,522 barrels, which came mainly

from the Ventura, Los Angeles and Santa Barbara districts.

The field in the city of Los Angeles was developed in 1892, the wells being of the shallow depth of about 800 feet.

Two mining prospectors, Edward L. Doheny and C. A. Canfield, decided in 1892 that petroleum deposits existed under the city of Los Angeles. They had noticed brea or bituminized sand strata that had been exposed by grading for a street in the western part of the city.

Their knowledge of petroleum was slight, but Mr. Doheny did know something of the laws of physics. He studied the pitch of the impregnated stratum and decided at what depth the sand would be saturated with the oil. He demonstrated the theory to his partner by laying a lump of sugar in a spoon of coffee. The coffee by capillary attraction rose into the sugar, which was heavily saturated at the bottom, the saturation becoming less and less pronounced toward the top of the lump. This, Mr. Doheny maintained, was the condition existing in the stratum they had observed.

Forthwith the prospectors purchased a

corner lot 40 by 140 feet in the residential section of the city at a point where they judged the highly saturated stratum to be at a depth of 200 feet or less. Then they started their well—not drilling, but digging it with pick and shovel, as they had been wont to do in their mining explorations. A two-compartment shaft 5 by 7 feet was sent down to a depth of 155 feet.

Some gas already having been encountered, the two men decided they had best change their well digging methods—for, if they had found what they were after, both probably would have been suffocated before they could have gotten out of the hole.

So they obtained a eucalyptus pole about 50 feet long, sharpened it and went to work drilling by the "spring pole" method. Finally a heavy oil came oozing up out of the drill hole, which had been sent to a depth of 15 feet below the bottom of the shaft. About six barrels of oil daily were taken from the well. It graded 17° Baumé.

Other wells then were drilled, the methods, in spite of the fact that neither Doheny nor Canfield ever had seen an oil field, being gradually improved. A short time later

George Owens, a former Pennsylvanian, was employed as a driller—and thereafter the Doheny operations were on a modern basis.

Later Mr. Doheny extended his activity to Mexico and now is one of the foremost as well as wealthiest men in the oil industry.

From the time of the opening of the Los Angeles field the production in California increased rapidly. The output in 1895 was 1,208,482 barrels. In 1903 the state took first rank as a petroleum producer with 24,382,472 barrels. Oklahoma produced more petroleum than California in 1907 and 1908, but in 1909 California again took first place with 54,433,010 barrels. The gain was steady from then until 1914, when a high point of 99,775,327 barrels was reached. Then came a slight falling off, with a 1917 production of 93,877,549 barrels.

California, in 1918, however, set a new record, producing, according to the Geological Survey's estimate, 101,300,000 barrels.

The opening of the Gulf Coast district, which embraces the coastal plain of Louisiana and Texas was perhaps the most spectacular event in the annals of the oil industry in the United States.

The Discovery well at Spindletop, near Beaumont, Texas, came in with a roar, ran wild for ten days and is estimated to have attained a maximum flow of 100,000 barrels a day.

This well was completed January 10, 1901, by Captain Anthony F. Lucas, now of Washington, D. C., after overcoming a most heartbreaking series of obstacles, both financial and in drilling practice.

Oil-well drilling prior to that time had been with cable outfits. This system was not successful in the unconsolidated formations encountered, so Captain Lucas was compelled to adopt the hydraulic rotary method, he previously having used this system in exploring the rock salt deposits of Louisiana—which explorations, by the way, were responsible for his arriving at the belief that the dome structures in that section of the country contained petroleum deposits.

Captain Lucas also devised a check valve for overcoming the terrific pressure from below that made the dissolution of the enterprise seem imminent.

The great Spindletop well was completed at a depth of about 1150 feet and at a cost of

less than $6,000. It marked the beginning of the fuel oil era, was followed by the formation of some of the most powerful independent oil companies of the country and opened an oil territory that up to the end of 1918 had produced close to 400,000,000 barrels of petroleum.

The Standard Oil Company, which at that time was dominant in the oil industry, looked upon the development as without merit because of the heaviness of the oil. This gave a clear field to the independent companies. The oil from the Lucas well, which was followed by "gusher" after "gusher" was of an asphalt base, graded 23° Baumé and had a sulphur content of 2 to 4%.

Many oil men other than the Standard Oil's experts held the heavy sulphurous oil, which was of a decidedly unpleasant odor, to be practically worthless. The refineries then in operation were not equipped to handle it. Its use as fuel as a substitute for coal was suggested, but the objection was raised that the sulphur would prove injurious to boiler fire boxes. This, however, proved a fallacy.

The Spindletop boom was perhaps the greatest ever seen in the United States, with

the exception of the California gold rush of 1849. Land values, leases and options shot skyward. Although the productive area proved to be only about 300 acres, the speculative frenzy was not limited by acreage.

Before the advent of the well, common prairie land in that locality was valued at about $5 an acre Then up it went through the hundreds into the thousands and then into the hundreds of thousands. Quarter-acre tracts sold for from $50,000 to $100,000.

Tracts as small as 25 by 25 feet changed hands, Captain Lucas relates, some of the leases only affording sufficient room for the erection of the derrick. Boiler room had to be arranged for by obtaining surface rights from a neighbor.

In one instance four companies, each capitalized at $1,000,000, owned jointly a tract 45 by 45 feet. The companies contributed equally to a fund for drilling a well in the center of the lot, each owning a one-fourth interest in the production. The well was completed and each company was enabled to advertise its stock in full-page displays in newspapers throughout the country. Need-

less to say, there were many disappointed stockholders.

Captain Lucas had many opportunities to lend his name to stock-jobbing schemes, but be it said to the pioneer's everlasting credit that he would permit none of it. In one case he was offered 10% of the capital stock of a $1,000,000 company for the use of his name. It was to be the Lucas Oil Company and Captain Lucas was to be president.

Naturally the prospective president manifested interest regarding the company's assets. The promoters spoke confidently, but in general terms. Then Captain Lucas demanded that he be taken to inspect the acreage. But, insisted the promoters, he was such a busy man that it shouldn't be necessary to take up so much of his time—anyhow, wouldn't a map do just as well? A glimpse of the map was sufficient, and Captain Lucas quietly declined the proposition. The promoters insisted on knowing his reason.

"There is no oil on that land!" Captain Lucas finally retorted in order to close the interview.

"What's that to you, Captain Lucas, so

long as you are made president and get your 10% of the capital stock, which would be worth par as soon as we incorporate?"

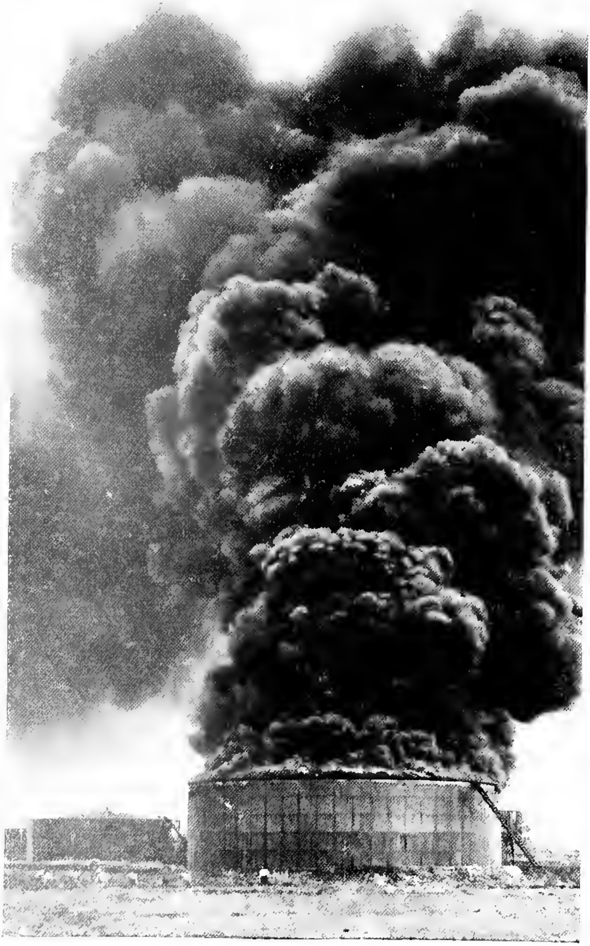
This came rather heatedly from the leader.

The spokesman of the promoters went through the door without any effort on his part. Of such stuff are made the men who are the backbone of the industry.

More than one spectacular fire was caused by oil held in earthen storage at Spindletop, as well as by the crowding of derricks on the dome. One of the most serious conflagrations occurred on March 3, 1901, less than two months after the discovery. It is estimated that 800,000 barrels of oil went up in the flames.

Finally solid development followed the hectic, boom period. Pipe lines were laid and refineries erected in the Gulf Coast territory. The discovery was the signal for a vast amount of exploration work on various other structures.

Following is a partial list of oil pools opened in this territory since the Lucas discovery: Jennings, Anse, La Butte, Saratoga, Vinton, Edgerly, Welsh, New Iberia, Caddo and Pine Island in Louisiana, and Sour Lake, Batson,



Flaming Oil Tank, Mid-Continent Field

Humble, Goose Creek, Hoskins Mound, Matagorda, Big Hill, Markham, Bryan Heights, Damon Mound, West Columbia and Hull in Texas.

The Gulf Coast is credited in 1917 with having produced 26,087,587 barrels, while the 1918 output is estimated to have been 21,700,000 barrels.

The most spectacular of all the oil "gushers" have been drilled in Mexico, recognized as the greatest potential source of fuel oil. One well completed early in 1916 showed the tremendous initial flow of 260,000 barrels a day—the greatest "gusher" in the history of petroleum. One well in Mexico was said to have produced up to about the end of 1918 approximately 90,000,000 barrels of oil.

Most of the production in Mexico is owned by American companies and it is estimated that in 1918 some 36,500,000 barrels of crude oil were shipped from Mexico to the United States. Some authorities place this estimate much higher. About 14,000,000 barrels are reported to have been exported from Mexico to other countries. The 1918 year, because of the growing demand for fuel oil, saw vigorous development work in the southern re-

public, wells with initial flow as high as 100,000 barrels a day being reported.

It has been possible, however, because of internal conditions in Mexico and as a result of a shortage of ships, to market only a fraction of the potential output of the wells already drilled—which early in 1919 was estimated at upward of 1,000,000 barrels a day.

The first year in which petroleum production was recorded in Mexico was in 1904, when the output was 220,653 barrels. By 1910 it had increased to 3,332,807 barrels.

In 1911, however, the output leaped to 14,051,643 barrels, this being largely the result of the bringing in of the famous Casiano No. 7 well in September, 1910. This well, since that time, is estimated to have been producing at an average rate of more than 20,000 barrels a day. The well in 1917 is estimated to have produced nearly 8,000,000 barrels, putting its total output since it was drilled up to nearly 60,000,000 barrels, or an amount practically equivalent to the entire Mexican output in 1917.

The greatest well in the world's history was completed in Mexico in February, 1916, when the Cerro Azul began to gush with a roar. Before it was brought under control

it is estimated to have reached a maximum of 260,000 barrels a day. This great well has been producing 30,000 to 50,000 barrels a day with the valve that governs its flow opened only slightly.

Permitted to flow at its initial capacity this well would produce oil at the rate of 180 barrels a minute—or three barrels each second. In a month the well would be capable of producing 7,800,000 barrels of petroleum—and, in a year, 94,900,000 barrels.

The following table shows the amount of crude oil produced in Mexico from 1904 to the end of 1918:

Year	Production (Barrels)
1904	220,653
1905	320,379
1906	1,097,264
1907	1,717,690
1908	3,481,610
1909	2,488,742
1910	3,332,807
1911	14,051,643
1912	16,558,215
1913	25,902,439
1914	21,188,427
1915	35,500,000
1916	39,801,110
1917	55,292,770
1918 (estimated)	63,000,000
	283,953,749

Although the oil deposits of Mexico were known to exist as early as the time of the Spanish occupation, nothing was done toward their development until 1868, when a Dr. Autray located the oil springs of Cugas and converted their yield into illuminating oil by means of a small still. Limited capital and the absence of a demand for the product finally resulted in the project being abandoned.

It was not until the early 80's that British interests decided to make an effort to develop the Mexican oil reserves. With the co-operation of American engineers and capitalists, drilling operations were started on a small scale.

The American engineers, however, did not appear to be well disposed toward the British activity. The result was that the British capitalists became disgusted with the lack of progress being made and finally withdrew from the project. That was just what the American engineers had been working for.

They then went to the American financiers who had been interested in the plan, explained the situation and sought further sup-

port. The drillers, however, were doomed to disappointment, for the Americans construed the suggestion as an excuse for wasting additional money. They could not see why they should make an additional outlay when the other money that they had invested along with that of their British associates had brought no return.

Sir Weetman Pearson, now Lord Cowdray, was engaged in the early 90's in the reconstruction of the Isthmian or Tehuantepec railway. On one of his visits to the scene of the construction work, the head of the firm observed evidences of oil near the railway line. Drilling was begun and oil was struck. Almost immediately there was erected a refinery with a capacity of 1,400 tons of crude oil daily. Thus began the real development of the Mexican oil fields.

The Pearson interest extended their field of operation, other capitalists soon obtained holdings in the territory and the immense reservoirs of oil lying in northern Vera Cruz soon were brought to light. It is in this district that the largest well in the world is located.

Another pioneer in the oil fields of Mexico

is Edward L. Doheny, who made his first purchases of leases in Mexico in 1900. With his partner, C. A. Canfield, this American petroleum expert prospected the jungles of Mexico in search of oil seepages.

Finally they hit upon the plan of offering the Mexicans five pesos each for pointing out to them the location of "tar spots." The plan worked successfully, and they were literally bombarded with "tar spots," the result being that they obtained leases on thousands of acres of land that to-day lie in the very center of oil-producing territory.

Most important of the oil fields of Mexico are those in the southern part of the State of Tamaulipas and the northern half of the state of Vera Cruz. They extend for about 50 miles back from the Gulf coast toward the foot hills in the states of Hidalgo and San Luis Potosi.

Important among the producing areas in this field are those known as Ebano, Panuco, Topila, Juan Casiano, Cerro Azul, Potrero del Llano, Agua Nacida and Alamo. This territory extends roughly from the seaport of Tampico southward to Tuxpam. The Pan-

uco pool lies only a short distance southwest of Tampico.

The present most active area of development, known as the southern field, lies on down the coast south of Tampico.

VI

MID-CONTINENT FIELD

Greatest of the oil fields of the United States is the Mid-Continent territory, embracing Oklahoma, Kansas, Northern Texas and Northern Louisiana. First Oklahoma held the limelight in this territory; then Kansas came in for some concerted attention, while in 1918 and 1919 the Ranger territory of North Central Texas became the center of attraction to oil producers throughout the country. At that time it appeared that the Ranger territory would prove perhaps the greatest field in the nation's history.

The North Central Texas territory in May, 1919, was producing close to 160,000 barrels of oil daily—and numerous wells either were shut in or drilled only to the top of the sand pending the construction of pipe lines.

The petroleum found in the Mid-Continent field is of a mixed paraffin and asphalt base, ranging from 28° Baumé near Humboldt, Kansas, to upward of 40° in the Cushing dis-

trict of Creek county, Oklahoma, and as high as 49° in the Garber field of Garfield county, Oklahoma.

Although the real development of this at present richest oil section in the United States did not begin until about 1904, it is recorded that prospecting was done in Kansas as early as 1860. G. M. Brown in that year attempted to drill a well near Paoli, Kansas, but, because of faulty drilling methods and a lack of machinery, nothing was accomplished. Drilling, however, was resumed in 1873, when several gas wells were completed near Paoli.

In 1889 about 500 barrels of oil were produced by a small well in Kansas. Petroleum requirements at that time were taken care of by the eastern fields, and it was not until some ten years later that any serious development work was undertaken.

As early as 1884 the Choctaw and Cherokee Indian nations of Oklahoma (then Indian territory) passed laws authorizing the organization of companies to drill for oil. These companies were merged under one control and in 1885 Dr. H. W. Faucett of New York began drilling operations near Atoka in the Choctaw

nation and near Talequah in the Cherokee nation.

The Cherokees in the following year repealed the law, which, although it later was re-enacted, caused the New York capitalists who were interested with Dr. Faucett to withdraw their support. St. Louis capitalists later were interested, but Dr. Faucett died in 1888 without having accomplished anything.

The next attempt at drilling in Oklahoma was made by Michael Cudahy of Omaha, Nebraska, who, in 1884, had obtained a blanket lease on the territory owned by the Creek nation. He drilled a well near Muskogee, finding a small quantity of oil at a depth of 1,120 feet. An effort was made to drill deeper, but it was necessary to abandon the well at a depth of 1800 feet. A second well then was drilled and oil encountered at 645 feet. This well also was abandoned at 1,300 feet.

A lease on a large part of the lands held by the Osage nation was obtained about this time by E. B. Foster, who completed a well producing five barrels a day. An unproductive well was drilled near Eufala in the

following year. The passage of legislation that was not favorable to oil developmnt resulted in practically nothing further being accomplished for about ten years.

In 1906 two doctors, Clinton and Bland, completed a productive well in the Tulsa-Red Fork district in the Creek nation. In the same year Galbrath and Colcord completed the first well in what now is the famous Glenn pool. This caused vigorous development, more than 100 wells being completed in 1906 in that territory.

The record of Oklahoma's production shows that in 1900 the output was only 6,472 barrels. Several wells were drilled in the vicinity of Bartlesville from 1901 to 1903, the oil coming from what is known as the Bartlesville sand, which has proved the most prolific in the state.

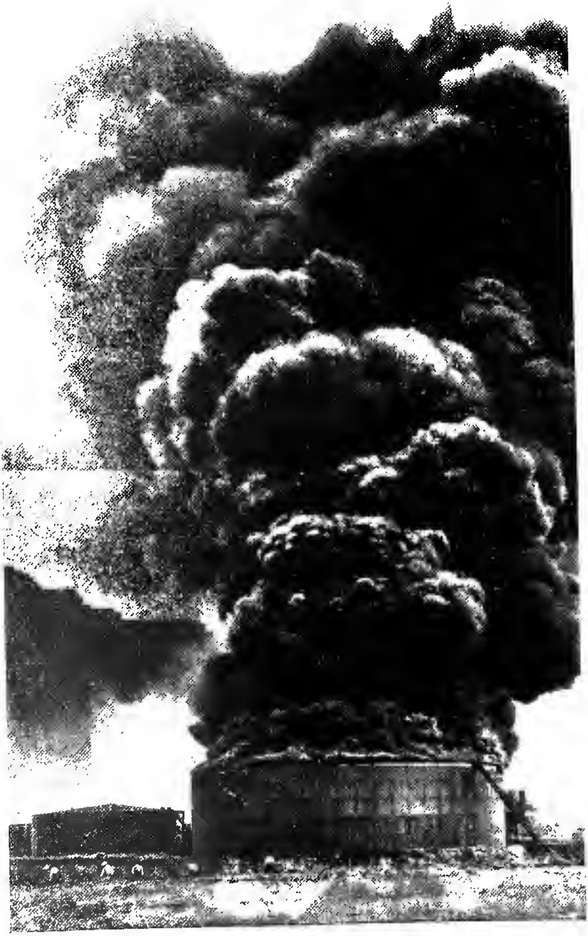
Oklahoma's production in 1903 is reported at 138,911 barrels, while in 1904 it increased to 1,366,748 barrels. From that time on the development was rapid, the 1905 figures being 6,466,200 barrels and the 1906 total 18,500,000 barrels.

The development of the Glenn pool, which is near Sapulpa, caused Oklahoma's pro-

duction to leap to 44,300,149 barrels in 1907. The state's output then increased until the 1911 figure was 56,069,677 barrels. Then, in 1912, there was a slight slump, with the output given at 51,852,457 barrels.

It was late in 1913 that the most sensational development up to that time in the history of the Mid-Continent field began. This was the striking of oil in remarkably large quantities in the lower Bartlesville sand in the Cushing field of Creek county, Oklahoma. The first wells in this field had been drilled to a shallow sand in this territory in 1912 by C. B. Shaffer. Their production dwindled rapidly, however, until operators were on the point of abandoning a territory that proved to be underlaid by the richest reservoir of high-grade oil in history.

From a total production of about 25,000 barrels in the month of December, 1913, the output of the Cushing field, which recorded "gusher" after "gusher," increased in a dozen months to more than 300,000 barrels daily. The effect of this development is shown by Oklahoma's production figures. The state's total in 1913 was 63,579,071 barrels. The total in 1914 was increased to



Flaming Oil Tank, Mid-Continent Field

97,631,724 barrels, while 1915 recorded a marketed output of 97,915,243 barrels.

Oklahoma's production in 1915, despite the low price of oil resulting from the Cushing "flood," was valued at $56,706,133. Production at Cushing fell off in 1916, but, despite that fact, Oklahoma's output reached the record figure of 107,071,715 barrels. The value was $128,463,805, or more than twice the 1915 figure.

Oklahoma and Kansas together in 1917 produced 155,043,596 barrels, while the output in 1918 was estimated at 139,600,000 barrels—as against the nation's total of 345,500,000 barrels! And prices were much higher in those years than in either 1915 or 1916.

The famous Cushing pool is about 35 miles west of Tulsa, the oil capital of the Mid-Continent field, and extends southward for a distance of some dozen to fifteen miles. Roughly the town of Oilton marks its northern limits, while Shamrock is near the southern extremity. Its production in the spring of 1919 was slightly more than 40,000 barrels a day.

The greatest of Cushing's "gushers" came in with a production estimated at approx-

imately 20,000 barrels a day. Wells of 2,000 to 5,000 barrels were frequent at the height of the development, a well with an output of 2,000 barrels daily being characterized as "just an ordinary producer." The 20,000-barrel well produced from the Tucker sand, which lies below the Bartlesville. There are five known productive sands underlying the Cushing territory.

At some points in the field, where small leases prevail, the derricks crowd each other most uncomfortably. Small leases and the resultant necessity for hasty drilling to prevent draining of territory by a neighboring well were the cause of the disastrously rapid development of the district. The flood of oil drove prices down temporarily to as low as 40c. a barrel. Thousands upon thousands of barrels of oil also were wasted because of a lack of pipe line and storage facilities.

The Cushing field lies in a rock and hilly territory, the surface being a red, sandy clay that is common in northern Oklahoma. Scrub oak is the prevailing timber, practically the entire territory being thus timbered. There is plenty of surface rock. In fact the country was not at all highly re-

garded before oil was found to underlie it. Which explains in a measure why it was allotted to the Creek Indians, some of whom now have royalty incomes that are so large almost to prove embarrassing.

In fact Jackson Barnett, a Creek "incompetent" who, in 1919, was 65 years old, late in 1917 had some $800,000 on deposit in various banks and was enjoying an income running into six figures annually. This information became known through Barnett's guardian, who sought official permission to invest a large portion of his charge's wealth in Liberty Bonds.

Barnett, who was the son of a Creek Chief, formerly lived the life of a recluse, spending his time hunting and fishing, persistently avoiding contact with white men. When Indian territory became Oklahoma and lands were allotted to members of the Five Civilized Tribes of Eastern Oklahoma, Barnett proved obstreperous. He didn't want any land—all he wanted was to be permitted to hunt and fish and smoke, unrestrictedly.

Finally the Government arbitrarily gave him a piece of land in what later proved to be the Cushing oil field. Barnett did not live

on the land, and even when oil in great quantities was gushing forth from his allotment he did not manifest any interest The Department of the Interior had attended to the leasing of the land to an oil company.

At first Barnett refused to accept more than a small amount of his income. All he desired was sufficient money to purchase provisions, tobacco and other supplies, a large part of which he frequently distributed among other members of his tribe less fortunately situated. It is said that his monthly expenses seldom exceeded $50, while his income in 1917 was running close to $50,000 monthly.

The superintendent of the Five Civilized Tribes offered to have a cabin constructed for Barnett, but he preferred his tepee. Finally, the cabin was built and, although Barnett accepted it, he insisted on sleeping on the porch both in summer and winter. Later, because of Barnett's actions, it was deemed advisable to appoint a guardian to protect his interests. Gradually he took on the ways of civilization, and got to the point where he made use of his blanket only for sleeping purposes.

But Barnett never became entirely inured

to the ways of civilization. An automobile was purchased for him, but he exchanged it for a flea-bitten pony valued at not more than $50. Since he was determined not to use a mechanical conveyance, his guardians decided Barnett at least should have a good riding horse. The horse was obtained, but it went the way of the automobile, Jackson protesting that it put his saddle too far from the ground—his choice continues to be a pony.

On the Barnett lease, in addition to many oil wells, is a casing head gasoline plant that is one of the largest in the world. As oil wells attain age the pressure of the casing head gas decreases, but the gasoline content increases. The wells in the Cushing pool have attained sufficient age and richness of gas to make the casing head gasoline industry a close rival in importance to the production of crude oil.

One of the tragedies of the history of Cushing is the fact that literally billions of cubic feet of gas were wasted in the early days of the field's development. The realization of the value of the product now is causing practically all of the gas to be utilized, first for the production of gasoline and then for fuel.

Cushing saw its greatest year from the

standpoint of production in 1914 and 1915. The greatest monthly output was in April, 1915, when the district yielded 8,658,000 barrels of high-grade petroleum. The pool's total for 1915 was 70,699,854 barrels.

The great flood of oil had an adverse effect on the price of petroleum, the price of Oklahoma crude oil dropping within a period of 22 days from $1.05 a barrel to 75c. a barrel, and the series of declines which followed in rapid succession sent the price down to a low level of 40c. a barrel in September, 1915.

Students of the situation, however, assert that over production was not altogether responsible for the low figure to which the price of crude oil dropped. They partially blame the general state of hesitancy brought about just at the critical moment by the outbreak of the war.

Toward the end of 1915 the situation had so adjusted itself that the price of Mid-Continent crude had advanced to $1.20 a barrel. And by the early summer of 1916 the quotation was $1.55 a barrel. It reached $2.25 a barrel in 1918 and was still at that figure early in 1919, liberal premiums over the mar-

ket quotation being paid for Cushing crude because of its high gasoline content.

The United States Geological Survey placed Kansas definitely in the producing list in 1889, with an output of 500 barrels. Oklahoma, according to the same authority, became a producer in 1891, with an output of 30 barrels. Kansas by 1896 had increased its production to 113,571 barrels, while Oklahoma in that year had an output of only 170 barrels.

In 1897 the output of Kansas was 81,098 barrels and that of Oklahoma only 625 barrels. Gradually both states increased their output until in 1904 Kansas produced 4,250,779 barrels and Oklahoma 1,366,748 barrels. In the following two years the Geological Survey kept the production of the two states in the same total, the 1905 output being given at 12,013,495 barrels and that of 1906 being put at 21,718,648 barrels.

The next year the figures were kept separately and they showed that Oklahoma produced 43,524,128 barrels, as against 2,409,521 barrels for Kansas. Gradually from that time on, Oklahoma increased her output, but after 1907 Kansas did not pass the 2,000,000-

barrel mark again until 1913, when her production was 2,375,029 barrels. The Kansas output in 1914 was 3,103,585 barrels—that year being followed by a decline in 1915 to 2,823,487 barrels.

Then prolific territory in Butler county began to be opened and the Kansas output climbed rapidly. The output in 1916 was 8,738,000 barrels. The 1917 year was the greatest in the state's history, the great wells completed in Butler county pushing the year's total to upward of 55,000,000 barrels

There was a sharp falling off in both Oklahoma and Kansas in 1918 as is shown by the decrease in the output of the two states from 155,043,596 barrels in 1917 to 139,600,000 barrels in 1918.

The principal oil-producing sections of Oklahoma follow: Washington county—Bartlesville, Hogshooter and Copan-Wann; Nowata-Rogers district—Nowata-Rogers, Delaware, Chelsea and Inola; Osage county; Tulsa county—Bird creek, Lost City, Red Fork, Sand Springs, Broken Arrow, Jenks, Bixby and Leonard; Okmulgee county—Mounds, Beggs, Youngstown, Hamilton Switch, Tiger Flats, Morris, Bald Hill,

Schulter and Henryetta; Muskogee and Wagoner—Coweta, Haskell, Stone Bluff, Boynton, Cole and Muskogee; Pawnee county—Cleveland; Creek county—Cushing and Shamrock, Glenn Pool, Sapulpa, Kiefer, Kellyville, Bristow, Mannford and Olive; Payne county—Yale and Quay; Kay county—Blackwell, Ponca city, Mervine and Newkirk; Garfield and Noble counties—Billings and Garber; Carter county—Healdton and Fox; Cotton county—Duncan and Lawton.

It is stated that the number of producing oil wells in Oklahoma on July 1, 1918, was 42,321.

In Butler county, the principal source of the Kansas output, are the El Dorado, Augusta and Towanda pools. It was the Towanda territory that in 1917 produced a well with initial flow placed as high as 20,000 barrels daily. Production also has been developed in less important degree in other parts of the state, one of the small pools being at Wellsville, in Johnson county.

Louisiana first is listed in the Geological Survey records as a producer in 1902, the year after the Lucas discovery at Spindletop, with 548,617 barrels. As the northern part

of the state is classified as in the Mid-Continent field and the southern lies in the Gulf Coast it is difficult to differentiate as to production between the two grades of oil. The state's output had grown to 2,958,958 barrels in 1904 and jumped to 8,910,416 barrels in 1905.

The principal Louisiana districts are the Caddo, Vinton, De Soto, Pine Island and Homer fields, the latter two being developments of 1917, 1918 and 1919. The Vinton field was opened in 1911 and the De Soto field in 1913. The state is credited with a production in 1913 of 12,498,828 barrels, while the output in 1914 was 14,309,435 barrels. The fields of Northern Louisiana alone are credited in 1917 with an output of 8,561,963 barrels, which was increased in 1918, as a result of the developments above mentioned, to an estimated total of 13,000,000 barrels.

The oils found in the Gulf Coast section of the state are heavy and asphaltic, while those found in North Louisiana are of a very much higher grade, ranging in gravity from around 30° to upward of 40°.

North Central Texas, with an immensity of development under way early in 1919 that

overshadowed any other oil activity in the world, began to attract real attention with the completion of a well in a deep sand near Ranger in Eastland county with an initial flow of 1800 barrels a day in October, 1917. This started such a frenzy of work that by the end of 1918 drilling operations had extended over an area one-half as large as the New England states.

Oil had been found previously in the Gulf Coast section of Texas and in limited quantities in parts of the state in close proximity to the new development. In fact the first oil development in Texas was in the sixties, when a small production was found at a depth of 100 feet near Nacogdoches.

Oil was found at a depth of 230 feet at Goose Creek in 1893. In the following year oil was found near Corsicana, which district in 1896 produced about 1,000 barrels. The state's output in 1897 was almost 60,000 barrels and the next year 546,000 barrels.

The Lucas discovery caused heavy operations in the Coastal section, the 1901 production being 4,393,658 barrels, which was increased in 1902 to 18,083,658 barrels. This development continued until a production of

28,136,189 barrels was credited to Texas in 1905. Thereafter there was a gradual falling off until the output in 1910 was 8,899,266 barrels.

Then followed an upward climb in output as a result of the discovery at shallow depths of high-grade oil in the central and north central portions of the state. Principal among these fields are Electra and Burkburnett in Wichita county, the latter of which underwent sensational new development in 1918. A field also was developed at Moran in Shackelford county in 1913. Other small fields also were opened.

The state's total production in 1913 was 15,009,478 barrels, while the output in 1914 aggregated 20,068,184 barrels.

Central and North Texas alone were credited in 1916 with more than 9,000,000 barrels. The 1917 total was 10,900,646, while the beginning of the Ranger development boosted the estimated total of this territory in 1918 to 15,000,000 barrels.

VII

RANGER AND NORTH CENTRAL TEXAS

"MOMENTOUS developments that affected the future supply of high-grade petroleum in the United States," says a bulletin issued by the U. S. Geological Survey early in 1919, "took place in 1918 in the Central and North Texas field, after petroleum had been discovered in considerable quantities near Ranger, Eastland county; near Caddo in Stephens county; near Brownwood, in Brown county; and near Burkett, in Coleman county in 1917." The campaign of drilling, it was added, "extended over 40 counties in northern Texas before the end of 1918 and will doubtless result in the opening of other pools of high-grade oil in 1919."

The daily production of the territory early in March, 1919, was estimated to be running at the rate of approximately 50,000,000 barrels annually—with the development just beginning to gain momentum.

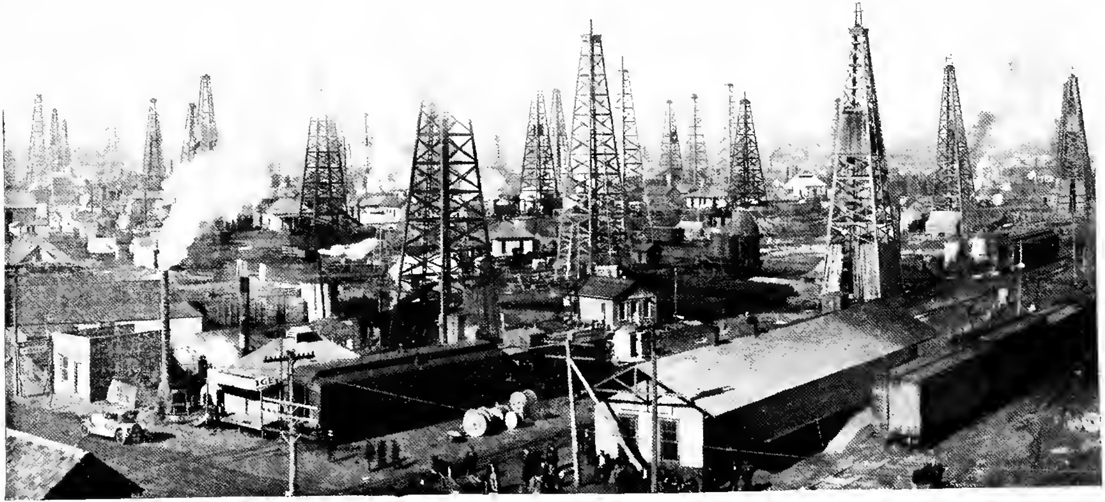
It was stated that at the end of 1918, twelve

counties in the new territory were credited with production of oil or gas, and seven counties in the list possessed oil wells with production ranging from 100 to 6,000 barrels a day each. New counties were being added to the producing column constantly.

In the late winter of 1918–19 there were completed in the field two wells that established new production records, one being credited with an initial flow of more than 12,000 barrels daily and the other almost 15,000 barrels a day. These wells were in Stephens county.

It was in August, 1918, that Burkburnett, in Wichita county, started on a career that soon placed it in the ranks of large producers. This resulted from the discovery of new producing territory in and adjacent to the town of Burkburnett.

The development program in the new territory is on a more gigantic scale than was ever outlined for any oil field. The spur of war-time need also was behind the development at its inception. There were completed in North Central Texas in 1918 a total of 1,188 wells with initial production of almost 150,000 barrels a day as against 1,020,



Town of Burkburnett, Texas
Spring of 1919

with initial output of 50,000 barrels a day in 1917.

North Central Texas in the winter of 1918 and, with growing force, in the spring and summer of 1919, leaped into a place of such importance in the oil industry as two years before would have made the most fantastic dreamer stand aghast. The boom which meant the salvation of the oil supply for a number of years yet to be determined centered at the town of Ranger in Eastland county, Texas.

The first well was drilled in October, 1917. Quickly the producing area spread into Stephens, Comanche and other counties—in fact in the early summer of 1919 it was estimated that drilling was in progress in 120 counties.

Oil authorities have asserted that the Ranger development safeguards the country's supply of high-grade petroleum for perhaps 20 years. They also assert that its daily production may advance to 300,000 or even 400,000 barrels daily.

Eastland, Cisco, Caddo, Breckenridge and other towns which theretofore had merely been centers of moderately—very moderately

—prosperous farming and cattle raising communities suddenly became seething centers of oil development and speculation. Ranger, which, when the first well was completed a few miles west, was a village of considerably less than 1,000 inhabitants, sprang mushroom-like to a population by the spring of 1919 of 20,000 to 25,000. Through its mud-clogged streets daily passed hundreds of wagons and motor trucks hauling casing, derrick timbers and other oil-well equipment.

The frenzy of quick fortune-making spread all over that section of the country. Fort Worth became wild with it. So did Dallas in only a slightly lesser degree.

A casual traveller could find no sleeping accommodations within a radius of more than 100 miles from the fields unless he was exceptionally fortunate. It became a common practice for men to have headquarters a night's ride from the development, thereby using sleeping cars instead of hotels and spending alternate days in the oil fields.

The Ranger development is what in the language of the oil man is called "a big company proposition." The oil sands are found at depths varying from 2,800 to more than

3,500 feet. Scarcity of water, difficulty in obtaining labor and material, coupled with the depth of the oil sands, made drilling exceedingly expensive, $50,000 being regarded as a moderate cost for a well.

Naturally a company with limited capital and its first well a "dry hole" often was in an embarrassing position. It was for this reason that the development of the field was carried out principally by the larger companies.

This "big company" idea also applied to lease holdings, which were larger than in the ordinary field. Large holdings reduce the number of possible offset wells, and thereby tend to prevent unreasonable haste in development work, with its consequent crude oil price slumps—as witness Cushing.

It was an entirely different situation at Burkburnett, however. This is a pool in Wichita county of limited area and with oil found at moderate depth. This development, coming at the same time as the great Ranger activity, was far more riotous than Ranger.

A large portion of the pool proved to be directly under the town of Burkburnett. This led to what is called "town lot" development. Each building lot in the town be-

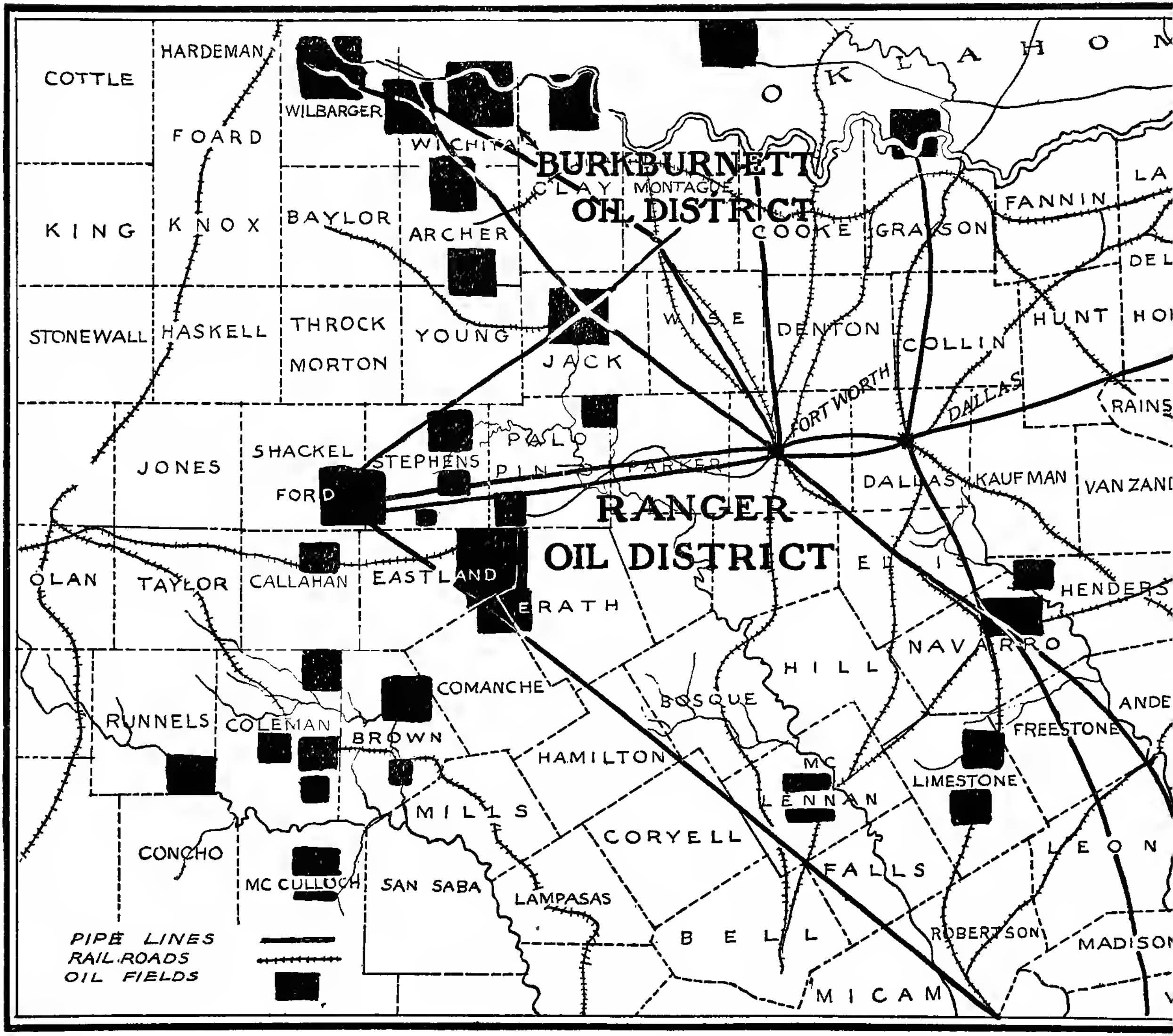
came an oil lease. Derricks crowded each other as well as the dwelling houses of Burkburnett. Householders received unheard of amounts for the privilege of drilling in their front or back yards.

Burkburnett, which was known (because of the low cost of drilling) as a "poor man's" field, became the center of operations for a host of small companies, although the development was not comparable in eventual importance with the Ranger territory.

The production of the three counties of Eastland, Stephens and Comanche early in April, 1919, was close to 100,000 barrels a day, while that of the Burkburnett territory was slightly more than half that figure.

It was generally predicted that the three other counties mentioned shortly would be producing 125,000 to 150,000 barrels daily—and these were only the original three of the many counties that at that time gave promise of figuring successfully in the development. Burkburnett, as a result of the opening of new productive territory, was producing 58,000 barrels daily early in May, 1919.

A company capitalized at $60,000 completed a 3000-barrel well on a 60-acre lease



North Central Texas
Scene of great 1919 boom

in this new section of the Burkburnett pool early in May and immediately afterward sold the lease for $2,000,000. This is only one instance to show what the field meant in new wealth.

Pipe lines into the field in the early summer of 1919 were capable of handling 100,000 barrels a day, with other lines under construction. Many oil men predicted a potential production for the district of as high as 300,000 barrels a day, from a geographic area 250 or 300 miles in length and 150 to 200 miles wide. These estimates, of course, await the future for confirmation.

At any rate the Ranger discovery proved the country's petroleum savior—and indicates the possibilities of future "finds" as the economic situation provides the oil pioneer or "wildcatter" with the necessary incentive for exploration.

Texas as it grew in importance as an oil producer, also began to take a higher rank in the refining end of the business. It was estimated in the early summer of 1919 that more than 40 refineries were under construction or projected in Northern Texas.

The oil spread its gold in many places—

places where it was the more welcome because it was unexpected. A farmer who was living in Fort Worth after oil was found on his land, complained that the worry of it kept him from getting much-needed sleep. He had been in the drouth-stricken area and in the farming days $15 or $20 was a large amount of cash to have on hand. The transformation from that to $7,000 monthly was almost too much for him to bear up under.

A bootblack in Fort Worth is reported to have invested his surplus savings with some experienced oil men. The result was that early in 1919 he was receiving $3,000 monthly—in addition to the profits from his shoeshining business.

Companies as well as individuals that invested wisely in this as well as other fields are taking immense profits out of the Texas fields. Not all have been successful—but not all have chosen wisely their lands, or the men with whom they invested their money. For, the state of Utopia still being apparently some distance away, a new oil field proves alluring to the crooked promoter, "lease grafter" and faker just the same as it does to an honest investor.

"Possibly no field in this country," says the *Oil City Derrick* of January 21, 1919, "has been developed with as small a loss in oil. This was due largely to the great care exercised by the big companies in not drilling a well into production until some storage or carrying capacity had been provided to care for the oil.

"According to estimates placed on the land holdings of Eastland and Stephens counties from the discovery of oil, they have a value to-day in excess of 10% of the total taxable property in the state.

"In Eastland county there are about 770,000 acres, on which a fair average lease market value would be $150 an acre and according to prices at which royalty values are selling, a fair average lease market value would be $150 an acre, making a total of $300 an acre on the 770,000 acres, or $231,000,000.

"In Stephens county there are about 550,000 acres on which an average market value for leases might be conservatively placed at $100 an acre and on the royalty at $100 an acre, or a total of $200 an acre. On 550,000 acres it will figure $110,000,000, making a total of $341,000,000 for Eastland and Ste-

phens counties in increased market value over and above the values before oil was discovered less than 15 months ago."

It was estimated in 1919 that about 80% of the wells drilled in the Ranger field had proved productive—truly a remarkable record for a new field, where the great proportion of operations is in unproved territory.

In the original Ranger pool (Eastland county), according to the *Lamp*, published by the Standard Oil Company of New Jersey, there had been drilled up to May, 1919, a total of 214 wells, of which 42 were dry. Some of these wells "came in" with production of less than ten barrels a day; others produced 5,000 to 12,000 barrels. Average initial production was computed at the high figure of 839 barrels a day to each well, while average production in May, 1919, was placed at 407 barrels daily.

Ranger apparently means doubling the profit and glory already achieved by the Mid-Continent field, which, in 1918, was responsible for 42% of the nation's oil output.

VIII

LEASING AND DRILLING

PROPERLY conducted, there is not the hazard in the oil business that is popularly attributed to it. In fact, it is doubtful if any other class of business ventures could show such a high percentage of successes.

In the new Ranger district of Texas, whose boundaries have not yet been defined, the drilling in 1919 was estimated to be about 80% successful.

One company that in 1918 drilled 52 wells in various Oklahoma districts reported that 43 were productive either of oil or gas, while nine were "dry." This shows that approximately 83% of the wells proved paying propositions.

The selection of lands on which to drill may spell either success or disaster for the embryonic oil-producing company. For, in some districts, such as North Texas and Wyoming, the cost of drilling a single well to the deep sands ranges (on a basis of 1918 labor and material prices) from $40,000 to $75,000.

The completing of a "dry hole" or "duster" at the start of a company's operations, unless the organization be amply financed, naturally proves a serious set-back. Hence the oil scout and geologist.

Before the leasing department of an oil company begins the work of taking up leases it is essential that the geologists have made a favorable report on the acreage in prospect. Then, after the leases have been obtained and before drilling is started, a careful investigation of titles must be made, and again the geologists must indicate the most favorable locations on which to drill. Proximity to marketing facilities is important. A producing oil well is not a particularly valuable asset unless the output can be sold.

The scouting department's duty is to supply logs of wells previously drilled in that territory, giving the formations encountered in wells drilled by other companies in adjoining districts. These logs indicate where water may be encountered, where the gas strata lie and where the producing oil sands may be found. The scout also gives information upon which the kind and size of casing and other drilling equipment is decided.

LEASING AND DRILLING

There is a standard lease form in the various districts, the oil company usually agreeing to give the owner of the land a royalty of one-eighth of the oil produced. In some cases, where acreage is in great demand, a higher royalty is paid. On the Osage Indian lands in Oklahoma a one-sixth royalty is paid.

Where the land is in an unproven or "wildcat" territory the oil company may obtain the lease for a nominal consideration, with rental payments of a few cents an acre a year to be paid until such time as the lease becomes productive. In most cases the terms of the lease call for the starting of the initial well within a specified period after the signing of the agreement.

In producing territories large bonuses frequently are paid for leases. Depending upon the regard in which the acreage happens to be held, the bonuses may range from a few dollars to $5,000 or even more an acre. In the Spindletop boom of 1901 quarter-acre tracts in the proven area are reported to have sold for $50,000 to $100,000.

When the oil producer, upon the advice of his geologist, has decided on the location of a

well, the first step is to get the drilling equipment on the lease. Probably this is done by the producer himself, or he may have the work done by a drilling contractor. Arrangement must be made for a supply of water for the boilers; or, if it be in a territory where drilling is by the rotary system, also to keep a column of water constantly in the hole. A derrick must be erected, a power plant provided, cables, drilling tools, casings and other materials provided.

Although local conditions frequently necessitate modifications, there are in use in the United States two general systems for drilling oil or gas wells. They are the standard or churn-drill system, and the rotary method.

The standard system sometimes is called the "percussion" or "American cable system," and consists in its essentials of a heavy steel bit attached to a rope or wire cable (usually rope), which is raised and dropped by means of a walking beam extending over the hole. This system is adapted to drilling in hard formations which permit the side of the hole to remain intact until it is advisable to insert a casing because of encountering a

water or gas-bearing stratum. This is the drilling method used as a rule in the eastern and Mid-Continent fields—in fact all the fields of the United States except the Gulf Coast and some parts of California.

The system is adapted also to use in somewhat softer formations than are encountered in these fields, by the use of what is called an "under-reamer." In such formations the tools are followed up by the strings of casings closely enough that the side of the hole does not cave and prevent the tools from being withdrawn.

When a well is started, it is necessary to make a hole of a certain depth before it is possible to insert the drilling tools and inaugurate the regular drilling procedure. Sometimes a hole is dug ten or fifteen feet to bedrock. Where the bedrock formation is too deep to permit digging, an iron "drive-pipe," with a sharp steel shoe at the lower end, is driven down.

Where it is less than about 60 feet from the surface to the rock formation, the "spudding" process is resorted to in order to give sufficient depth to the hole to permit drilling in the usual manner. In this process, the

drilling tools are raised and dropped by tightening and then slacking the cable, a "jerk rope" held by the driller and the axle of the bull wheel usually being the instruments to accomplish these results.

One end of the drilling cable is attached to the bull wheel, on which it is spooled. The cable is passed over the crown pulley on top of the derrick; from there down through what is known as the temper screw, which is fastened to the end of the walking beam, and on down into the hole. The temper screw is attached to the cable by means of clamps. The drilling cable being firmly held by these clamps, the drilling is accomplished by the raising and lowering of that end of the walking beam.

The string of drilling tools consists of a socket, jars, drill stem and bit. The tools are joined together by means of box and pin connections. At the top of the string of tools is what is known as a rope socket, which is used to connect the rope or steel cable with the rest of the tools.

The jars, when they are used, usually are attached just below the socket. As the name would indicate, they are used to jar the tools

loose when they become stuck in the formation being drilled through.

Next comes the solid drill stem, to the lower end of which is attached the bit. The stem varies in length and diameter according to the requirements of the hole in which drilling is being conducted.

The dressing of the bit varies according to the nature of the formation and the ideas of the driller. The bottom edge in some cases is beveled, while, in others, it is dressed concave.

When drilling in clay or other sticky formations it frequently is the practice to use a sinker bar between the jars and the socket. The function of a sinker bar is to add weight to the blow of the jars in their effort to release the bit when it becomes stuck.

The drilling crew consists ordinarily of a driller, a tool dresser and an engineer. It is the driller's duty to rotate the drill by means of a short lever inserted in the rings of the temper screw. As the drill progresses in depth, he lets down the temper-screw at frequent intervals to put a greater length of rope in the hole. Likewise, he determines when the drill bit needs sharpening, and the hole cleaned.

The bull wheel is called into action to withdraw the tools from the hole. While the tool dresser is removing the bit after the tools have been withdrawn from the hole, a bailer or sand pump is sent down to clear the bottom of the hole for further operations of the drill. The pump, or bailer, is sent down into the well as many times as is necessary to remove the water or sediment from the bottom of the hole. A separate line, which passes up over a pulley on the crown block, is used to perform this operation. After the hole has been cleaned the drilling tools again are sent down into the well.

When water or a caving formation is encountered, casing is inserted and drilling proceeds with a smaller bit. When succeeding strings of casing for any reason are required (the first having been set in some hard formation), they, of course, must be of smaller diameter than the first in order to be passed down into the hole.

In some districts it is necessary to start casing the well very soon after drilling is started. On the other hand, in some of the eastern territories of the United States, it is possible to drill to a depth of 2,000 feet or

more without inserting casing, except to exclude water before tapping the oil bearing sand. The structure in some parts of Mexico also is said to permit drilling to a depth of about 2,000 feet without inserting casing. This is called drilling with an "open hole."

It is the general practice to tap the oil sands with a well six to eight inches in diameter, four inches being the minimum. At the top of the hole the maximum diameter in the United States so far as known is 20 inches.

The rotary drilling outfit, which is more costly than the type previously described, consists of a drilling stem—usually of six-inch pipe—to which is attached the bit or cutting tool at the lower end, provided with a hole for the circulation of water. These are rotated by means of a gear, or turntable, provided with grips, power for the driving of which usually is supplied by a gas or steam engine.

A constant circulation of muddy water is maintained by a special pump. This water goes down through the inside of the drill stem and through the hole in the bit at the bottom and comes up the outside of the stem. In addition to carrying the pulverized matter

up out of the hole, this constant flow of water also serves to keep the bit cool.

Because of the fact that in some districts part of the hole stands up very well, while certain other formations in the same hole cave badly, it frequently is difficult to determine whether it is advisable to use the standard cable system or the rotary system.

In territories to which each is best adapted, the rotary is said to excel a standard rig so far as time of drilling is concerned. With standard tools it requires about thirty days to drill a 2,000-foot hole in Pennsylvania and West Virginia, while it requires only from fifteen to twenty days to drill a 2,000-foot hole in Louisiana with a rotary rig. However, it requires a crew of from ten to eleven men to operate a rotary, as against three or four men for a standard rig.

A dependable supply of water is necessary to the operation of a rotary outfit. One of the disadvantages of the heavy column of water which is used in a rotary hole is that small showings of oil or gas sometimes are not observed at the top of a hole. For this reason, the cable system is declared to be better adapted for prospecting work, because

of the fact that the dry hole permits the operator to determine definitely regarding the formations through which the drill is passing.

When a field once has been located and it is possible to determine the depth at which the oil sand is to be encountered, this feature does not assume the importance that it does in new territory, and it is possible to use the rotary machine satisfactorily, if it is adapted otherwise for use in that field.

Although in the past it was the tendency to take chances on being able to control the flow of the well after it had been drilled in, the rule now is to take precautions before the drilling-in process against the possibility of the well flowing "wild."

The drilling tools are removed from the hole and what is known as a control casing head is put on, a gate valve being attached to a long, heavy split-sleeve or collar. The two halves of this sleeve are bolted to the casing a short distance below the mouth, so as not to interfere with the work of completing the well, the drill then being inserted and operated very cautiously as the oil or gas-bearing structure is penetrated.

There also are other methods by which the valve is so arranged that it does not interfere with the passage of the cable during drilling. After the tools have been withdrawn it is possible to swing the valve into place, and thus close the well without any delay.

It sometimes is the case, however, that pressure develops in such unexpected volume as to require special methods of control.

The "shooting" of an oil well is not, as sometimes is believed, an invariable practice. It is resorted to only in hard rock formations, or where the oil-producing sand is so densely packed or lacking in gas pressure as to refuse to release the oil except grudgingly.

When it is found necessary to shoot, a charge of nitroglycerin is exploded in the oil sand after the well has been drilled in, but before it is put to producing.

The quantity of nitroglycerin varies, according to the conditions, from a few quarts to 500, or even 600 quarts. These large shots are used in the extremely thick and compact formations of North Texas.

The explosion shatters the formation, thereby enlarging the surface from which the oil can filter into the hole, and creating a

reservoir in which the oil may collect at the bottom of the casing.

If the well has been drilled into an area containing a small quantity of oil in close proximity to a more porous body of sand which contains oil in larger quantities, the shock of the explosion may open up a connection with a better reservoir. Cases have been known in which production has been obtained after "shooting" a well that apparently was dry when drilled into the oil sand.

Also in some fields "shooting" has resulted in production from shallow sands that, in the early history of the fields, were regarded as too insignificant for production. This practice is coming into vogue in Oklahoma, and a great deal of production now is being obtained from sands that when the drill first went through them were regarded as of no importance.

The practice of "shooting" a well also frequently is resorted to when production has fallen off to a point where the well no longer is a paying proposition. "Shooting" in such a case frequently results in considerable stimulation of output.

The "shooting" is accomplished by lower-

ing one at a time nitroglycerin canisters $3\frac{1}{2}$ to 5 inches in diameter and up to about 10 feet in length. After the required number of canisters have been lowered to the bottom of the well, what is known as a "jack-squib" is dropped into the hole to explode the nitroglycerin. This contrivance bears a fuse which is lighted before it is dropped.

Some oil wells have sufficient gas pressure to produce by natural flow for a considerable time after their completion. When this gas pressure dwindles to such an extent that it no longer forces the oil up out of the casing, it is necessary to install a pump. In the older fields it frequently is necessary to install a pump before any production is obtained from a new well, or else very soon after the well's completion.

The oil driller's task is one which requires a great deal of ingenuity, because of the numerous problems with which he must cope. Now and then a cable breaks, and it is necessary to "fish" for the tools, or it may be necessary to "under-ream." In fact, the difficulties that a driller may encounter are innumerable.

Despite the expense involved and the dif-

ficulty of the task, there is a relatively small percentage of failures in the drilling of oil wells in proven territory. In the Mid-Continent fields, for instance, it is asserted that only 10 to 15 per cent of the wells drilled are failures; while figures for Oklahoma show that nearly 90 per cent out of a total of 23,000 were successful.

IX

REFINING OF PETROLEUM

When the crude oil gushes or is pumped from the wells it is still a far cry to gasoline, sewing-machine oil, asphalt roofing or medicinal salve. It must be transported first to the refineries by pipe line or tank car and there started on the process of disintegration, which, if it is carried out to the limit of science and ingenuity, may result in hundreds of different products.

The genesis of the refining industry in the United States is attributed to Samuel M. Kier of Pittsburgh, Pa., who in the late forties erected a small still which produced illuminating oil from the petroleum produced by the salt water wells at Tarentum, Pa. This must have been at least ten years before the bringing in of the Drake well, which is declared to have been the first well drilled for the express purpose of obtaining petroleum.

Mr. Kier previously had marketed petro-

leum obtained from the salt wells as a medicine. Its value as an illuminant, however, also had been recognized, although in its crude state it was far from an ideal substance for that purpose.

With the idea in view of obtaining a satisfactory lamp oil from petroleum, he submitted some of the crude oil to a chemist for analysis. The chemist reported that certain constituents of the oil would make an excellent illuminant. However, he made no suggestion regarding a possible plan for obtaining it from the crude petroleum.

Mr. Kier then set to work on the problem and built a still, the original having had a capacity of one barrel, or 42 gallons, of crude oil. Combined with his task of evolving a new illuminating material was the necessity of developing a lamp in which it could be burned satisfactorily.

Experimenting at the same time with the oil, which be called "carbon oil," and with lamps he finally succeeded in refining and clarifying the oil so that it made a steady, clear and clean illuminant. The objection to petroleum as an illuminant in its crude state had been that its odor was offensive

and combustion resulted in considerable smoke.

Mr. Kier's next still had a capacity of five barrels of crude oil. The illuminating oil that was produced met with a ready sale at $1.50 a gallon. The purifying process for lamp oil was improved later by the use of acids. Mr. Kier, not having obtained a patent on his process, was not able to continue his monopoly after the bringing in of the Drake well. The five-barrel still used by Mr. Kier is reported to be preserved by his descendants at Salina, Pa.

Shortly after Mr. Kier began to refine petroleum and before his product had obtained more than local distribution, several refineries sprang up in the East for the distilling of combustible oil from shale and from coal. The development of the petroleum industry beginning with the Drake well, however, put an end to this branch of the business for more than a half-century. Just now, however, oil shale is beginning again to attract attention as a future source of petroleum.

An indication of the rapid increase in the consumption of refined oil is conveyed by the

fact that in March, 1863, the daily production of refined oils in the United States was from 1,200 to 1,500 barrels. Daily production of crude oil at that time was estimated at 5,000 barrels. In 1918 the refineries of the United States had daily capacity averaging 1,338,276 barrels and are estimated to have handled an average of 894,697 barrels of crude oil daily.

There has been no change of principle in the refining of oil since distillation was hit upon. Methods, however, have been improved and special processes evolved.

The oil refinery to the layman is a baffling network of buildings, stills, connecting pipes, tanks and loading racks. It, however, is not such a confusing place after all. The object of a refinery is, through various processes of distillation and purification, to separate crude oil into its various products. The separation first is into general groups of products, which in turn are separated into minor groups and products until the marketing stage is reached.

As the various products of petroleum have different boiling points, the process of distillation is the principal one. The oil is

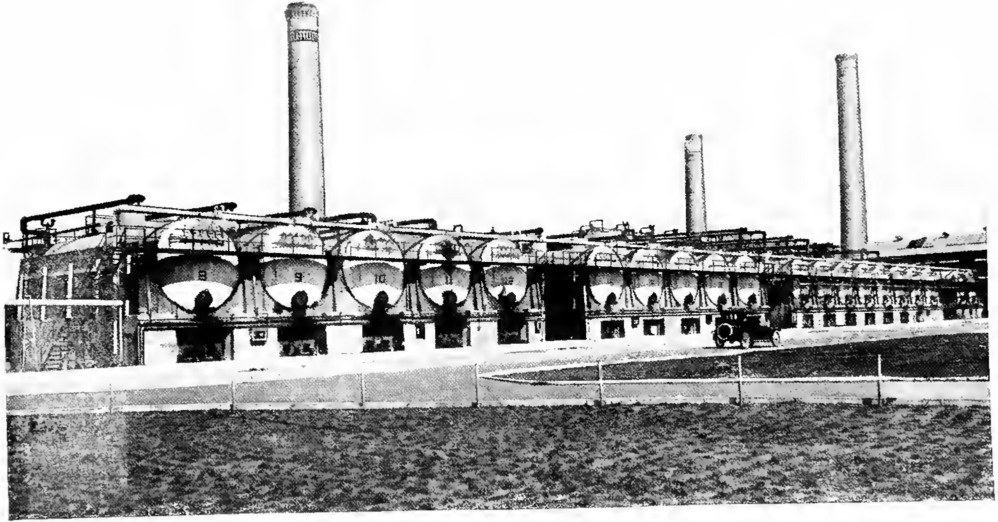
subjected to varying degrees of heat in huge stills. Into some of the stills steam is injected to assist in carrying off the oil vapors. The vapors are condensed by cooling and the different groups of products, by means of an intricate system of piping and manifolds, are sent to the proper receptacles.

The refiner knows the boiling points of the various groups. When a certain temperature is reached the receptacle into which the previous group has been sent is closed and the condensed vapors formed at the higher temperature are piped into another receptacle.

The fluids as they flow from the condensers go through what is known as the "receiving house," where, in passing through glass enclosed "look boxes," they are subjected to the scrutiny of an expert.

The usual practice is to take samples each hour and test them for specific gravity. In this manner the operator is able to determine when the fluid ceases to belong to the kerosene group and enters the gas oil or other classification.

The first "cut" consists of naphtha, or crude gasoline; the second is the kerosene group; the third the gas oil, and then the



Crude Oil Stills
Each with capacity of 1,200 barrels

heavier oils, lubricants and waxes. The number and nature of the groups is variable, according to the methods of the refiner. These various groups overlap somewhat, but this is remedied through the redistilling, filtering and other purification processes to which each group is subjected in order to obtain still greater differentiation of products.

A process which is coming into greater and greater use in refining in order to increase the percentage of gasoline obtainable from the crude oil is known as "cracking." This involves an entirely different principle from ordinary distillation.

The chief elements in petroleum are carbon and hydrogen—80% to perhaps 88% of carbon and 10% to 15% of hydrogen. Other elements, such as sulphur, nitrogen, oxygen and salts also are found in varying amounts in some grades of crude oil. They usually are looked upon as impurities. In fact it was one of the early problems of refining to devise a means of eliminating sulphur, which is especially noticeable in Illinois and Gulf Coast oils.

The various products of crude oil are composed of molecules containing carbon and

hydrogen in different proportions. For instance the molecules that form gasoline contain carbon and hydrogen in different proportions than kerosene or gas oil molecules. In ordinary distillation the crude oil separates into the various groups and products without any change in the molecules.

"Cracking" is a process of subjecting the products of a certain group to extreme heat and pressure, thereby breaking up and changing the nature of the molecules so that they contain carbon and hydrogen in new proportions. By means of this process substantial amounts of gasoline that would not be available through ordinary refining processes are obtained from gas oil or fuel oil.

Numerous "cracking" processes have been evolved, the most widely used being the Burton process, patented by the Standard Oil Company of Indiana and used by numerous other companies under royalty arrangements. It is estimated that the Standard Oil companies as early as 1916 obtained from oils formerly used in artificial gas manufacture or in direct competition with coal some 5,000,000 barrels of gasoline.

The percentage of gas oil obtained from

Mid-Continent crude averages about 20. At a price of 4c. a gallon a barrel of this product would be worth $1.68, according to a refiner who discussed with the writer the financial benefit to be derived from "cracking" the oil. By "cracking," he said, about 32%—or 13 gallons—of 59° gasoline could be obtained. At 24c. a gallon this would have a market value of $3.12, while the 29 gallons of residue at 3c. a gallon would add 87c.—a total of $3.99. On this basis the "cracking" of a barrel of gas oil would add $2.31 to its market value.

One of the heaviest sub-groups in the refining of oils of a paraffin base is known as paraffin distillate. This contains a large percentage of paraffin or wax. An intricate process of chilling and pressing (which, in reality, is filtering) is necessary to separate the wax from the lubricating stock.

Other products are subjected to "settling," chemical treatment, washing and filtering to remove impurities.

Crude gasoline, for example, is placed in an immense upstanding tank called an "agitator." The bottom of the tank is funnel shaped, with a small opening. The crude

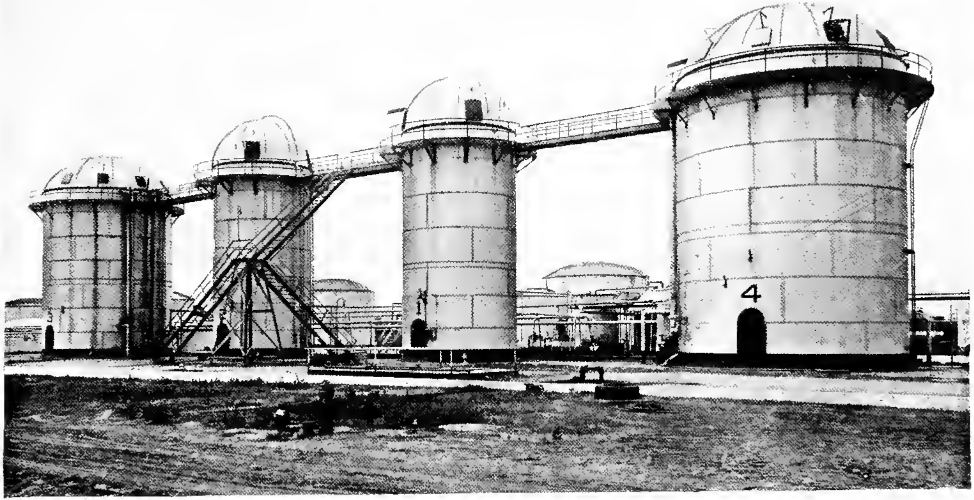
gasoline is run into the tank. Then sulphuric acid is added. Air then is forced in through pipes that have their outlet near the bottom of the tank. This "agitates" the contents of the tank violently, thoroughly mixing the gasoline and acid.

Later water is put into the tank from the top. It, being heavier than the gasoline, passes down through the gasoline, carrying most of the acid and the impurities collected by the acid, to the bottom of the tank. The water and acid then are drained off through the opening at the bottom, leaving the gasoline in the tank.

Then, after the gasoline has been washed, caustic soda is added in order to neutralize whatever acid may remain. Then it again is washed and is ready for the market or for redistilling.

Other distillates are washed and treated in a similar manner in specially constructed "agitators." One of the substances commonly used for filtering is Fuller's earth, which absorbs the impurities as the oil passes through. Fuller's earth also is used in separating lubricating oil into its various grades.

Refineries differ greatly as to the extent to



Battery of Agitators
Each treating 12,000 gallons of gasoline daily

which they carry out the separation process. Other differences in construction and methods are made necessary by the different nature of the various grades of crude oil.

The basic substance in the Mexican, Gulf Coast, California and some of the Mid-Continent and Wyoming oils is largely asphalt, while paraffin predominates as the basic (or heaviest) substance in most of the oils found east of the Mississippi river, in the Mid-Continent field and in Wyoming.

The heavy, or asphalt oils, which are relatively deficient in gasoline content, sometimes are used for fuel without refining. In other cases merely the lighter distillates are removed and the remainder disposed of as fuel oil.

A refinery that removes only the lighter distillates is called a "topping" or "skimming" plant. There are, however, numerous plants that carry the refining of these heavy oils down to asphalt and coke.

In connection with two immense "skimming" plants in Wyoming there are operated by other companies plants which use one of the most efficient of the "cracking" process. The "cracking" plant owners have long-

term contracts with the "skimming plants" for the oil after it has been treated by ordinary refining methods.

Gasoline content of the different grades of crude oil ranges from almost none in some of the heavy Mexican oils to 25%, 30% and, in some cases, up to above 40% in some of the oils found in Northern Wyoming and Oklahoma.

Following are the percentages of the various fractions obtained from Pennsylvania grade of crude obtained by a certain refining process, the different groups being given the names by which they are known to refiners: Gasoline, 25%; turpentine substitute, 15%; kerosene, 15%; 300 oil, 15%; non-viscous neutral oil, 12%; viscous neutral oil, 8%; S.R. cylinder stock, 8%; refined paraffin wax, 2%; There also was a 5% loss in manufacture.

By the same process Cushing crude yielded the following: Gasoline, 30%; turpentine substitute, 20%; kerosene, 15%; gas oil, 15%; viscous neutral oil, 10%; S. R. cylinder stock, 6%; refined paraffin wax, 0.5%; asphalt, 3.5%. This oil also showed a 5% loss in gallonage in manufacture.

The "300 oil" and "gas oil" are the same.

The "turpentine substitute," as its name implies, is used largely in the mixing of paints. The neutral oils and "cylinder stock" fractions embrace lubricating oils of various grades.

The profit of the refiner varies greatly, being dependent on the size and efficiency of the plant, the extent to which the refining process is carried out, location of the plant, marketing methods and numerous other factors. The elements governing profits are so variable that even a rough percentage table would be of little or no value.

A rough basis of price classification used for crude oil is based upon specific gravity, which is related to amount of the light or more valuable constituents. This method, however, cannot be relied upon for arriving at the values of heavy oils whose usefulness is based not upon its content of lighter distillates, but upon its value as fuel as compared with coal. The gravities of crude oils are arrived at by means of what is known as the Baumé scale, the temperature of the oil on which the test is based being 68° F.

The heavy oils of California and the Gulf Coast fields show specific gravity of 12° to

25° Baumé (there are, however, some oils in California with specific gravity running possibly as high as 40°); while the oils of the Mid-Continent, Illinois and Appalachian fields as a rule show a gravity of 32° to 49°. There is a relative scarcity of intermediate oils with a gravity of 27° to 32°, as well as those of extremely high gravity, such as Pennsylvania crude, with about 44°.

There were in operation in the United States at the end of 1918, according to the Bureau of Mines, 267 refineries with daily capacity of 1,226,175 barrels of crude oil.

The daily average of crude oil run to stills in 1918 was 869,618 barrels, as against the 1917 average of 863,374 barrels. Average runs in 1916 were 674,842 barrels daily, with about 524,000 barrels in 1914.

But it is not with crude oil as a working basis that millions of gallons of gasoline now are being placed on the market each year. The precious fluid of an extreme richness is being obtained from natural gas—and it is here that lie great possibilities in the line of conserving the nation's supply of gasoline.

From this source millions of gallons of gasoline are obtained annually that formerly were wasted.

Two methods of extraction are employed, depending upon the kind of gas. One is the compression and condensation process, and the other the absorption process.

Casing head natural gas is the gas that flows from oil wells. It is what is known to oil and gas men as "wet gas;" the product coming from gas wells being known as "dry gas." Use has been made of casing head gas for light and fuel at oil wells almost from the beginning of the industry, but it was not until a dozen years ago that there began to be a realization of its true value.

It is said that the first extraction of gasoline from casing head gas was accomplished in 1903. Since that time it has grown—slowly at first, but with great rapidity in recent years—into an industry of gigantic proportions.

In fact, the United States Geological Survey places the amount of raw gasoline recovered from natural gas in 1917 at 217,844,104 gallons, a gain of 114,391,415 gallons, or 111%, over the 1916 output.

Because of its extreme volatility it was necessary to mix this raw gasoline with a refinery product of lower grade in order to obtain commercial gasoline. The quantity of commercial gasoline resulting from the raw product in 1917 is estimated roughly by the Geological Survey at more than 300,000,000 gallons.

The volume of natural gas sent through the plants to obtain this amount of gasoline is estimated at 429,000,000,000 cubic feet, and the average recovery of gasoline per 1000 cubic feet by all methods was about one-half gallon.

The number of plants for extracting gasoline from natural gas increased in 1917 from 596 to 886, a gain of 49%. Combined daily capacity of plants increased during the year from 495,448 gallons to 902,385 gallons, or about 82%. It is evident, therefore, that the 1918 production also registered an immense gain over the preceding year.

The gasoline content of the various kinds of natural gas varies widely, the highest average in 1917 (the gasoline being extracted by compression from gas obtained from oil wells by means of vacuum pumps) was

slightly more than 3 gallons from 1,000 cubic feet of gas. This was in Louisiana.

Oklahoma was the largest producer in 1917 with 115,123,424 gallons valued at $21,541,905. This was more than half of the country's output of natural gas gasoline, which had a market value of $40,188,956.

George A. Burrell, formerly in charge of research work in the United States Bureau of Mines, draws an analogy between the occurrence of gasoline in natural gas and the occurrence of water vapor in the air.

"Natural gas," writes Mr. Burrell, "is the invariable accompaniment of oil. On it the pressure in an oil well depends. High pressure in the strata forces a large quantity of the gas into solution in the oil. Oil wells that flow or 'gush' do so because there is sufficient gas pressure to raise the oil from the sand through the casing of the well and often throw it high in the air. When a flowing well first comes in, oil and gas travel up through the casing together.

"In a new field the amount of gas that may be lost is tremendous, because facilitics can readily be provided for handling oil, but not for taking care of the gas. The loss of oil

can be reduced to a minimum from a flowing well by providing a flow tank connected to the casing head; and providing oil savers and control casing heads. Gas and oil can be separated in the flow tank, the oil being drawn off into receiving tanks and the gas escaping into the air.

"The gas in intimate contact with oil through the casing and through lines into the flow tank absorbs a large proportion of the light constituents of the oil, i.e., the gasoline. Although the amount of gas escaping from flowing wells is tremendous, and is frequently saturated with gasoline, it is seldom treated for gasoline extraction because the supply is temporary and uncertain.

"In the next stage the well settles down to a period of pumping. Oil is withdrawn through an inner casing and gas escapes from around the inner tubing and into the air at the casing head. Thus it has been in contact with oil in the strata and necessarily must be more or less saturated with part of the oil. This part is the gasoline. The constituents in the oil that are picked up and which mainly concern the natural gas gasoline operator, because they are the principal constituents

of casing head gasoline, are the pentanes, hexanes, heptanes and octanes."

From some oil wells the flow of casing head gas is as low as 1,000 or 2,000 cubic feet a day, while some of the wells give forth several million cubic feet in 24 hours. It has been found, however, that the higher the pressure of the gas the lower the gasoline content.

Consequently, as the wells reach the stage of settled production and pumping is resorted to, the gas becomes richer in gasoline. Likewise, the higher the temperature of the gas as it comes from the well the larger the amount of gasoline it is able to hold in suspension. The same rule applies here as to water vapor in the air.

Depending upon the pressure, temperature and other factors, casing head gasoline contains amounts of gasoline varying from less than one gallon in 1,000 cubic feet to as high as six gallons or even more to 1,000 feet. In fact gas from some of the wells in the Kiefer field of Oklahoma is said to contain 10 to 12 gallons of gasoline to 1,000 cubic feet, practically none of the gas remaining after it has passed through the plant. Govern-

ment statisticians, however, place the average recovery at 2.57 per 1,000 feet of gas.

Comparatively simple laboratory tests have been devised for determining the gasoline content of natural gas. These are useful to the oil producer in arriving at a decision regarding the possible profit to be derived from a plant for extracting gasoline from a given volume of casing head gas.

The method usually selected for obtaining gasoline from "wet gas" is the compression and condensation process. In this, according to Mr. Burrell, single and two-stage compressors are used as a rule. Single-stage compressors ordinarily are used where pressures do not exceed 110 pounds a square inch, although they are used at some plants where pressures up to 150 pounds a square inch are employed. As the compression increases, what is called the volumetric efficiency, decreases until, with a 150-pound single-stage compressor, it is only about 50 per cent.

In the two-stage method the gas is compressed from 15 to 50 pounds per square inch, 35 pounds probably being an average. The temperature of the gas, according to Mr. Burrell, may rise to 450° F., but no condensa-

tion of gasoline occurs, because gases above this critical temperature may not be liquefied by pressure alone.

It is at this point that the condensation process begins. In this stage of the operation the mixture passes through water-cooled pipes. It is stated, however, that usually little liquid is obtained at this stage, but that which is obtained is collected and added to the main condensate. At some plants the amount is as much as 15% of the total.

"After the mixture of gas and vapor has left the first cooler," says Mr. Burrell, "it is conducted to the high-pressure cylinder of the compressor and subjected to a pressure varying perhaps from 200 to 300 pounds per square inch. The temperature is raised probably to 250° C. (482° F.) in the compression cylinder. The mixture, still under pressure, is next forced through pipe coils on which water of ordinary temperature falls. In some plants the coils are immersed in concrete vats in the ground.

"An average temperature of probably 32° C. (90° F.) in summer and 40° C. in winter is maintained in the eastern part of the United States.

"The temperature is further reduced in some plants by passing it through expansion cooling coils, where it is rendered very cold while still at a high pressure by means of the expansion of residual dry gas into pipes surrounding it. The major portion of the gasoline is condensed following the reduction in temperature of the high-pressure gas.

"The gas, stripped of its gasoline, then passes out of the expansion nozzle of the high-pressure coils and is in turn expanded against a low-pressure into the expansion coils. This residue gas is then piped away to natural gas lines or returned to the oil lease for operating pumps."

Casing head plants usually are located near the wells, it being desirable to construct them at points where it is possible to take the product from as many wells as possible. In some instances the gasoline extracted from the gas has proved a greater source of income for the oil operator than the oil production. The same may be said to apply regarding the gas itself. Casing head gas may be drawn from a well by the vacuum method long after it has ceased to be a producer of oil.

The absorption process of extracting gaso-

line from natural gas may be said to begin where the compression and condensation process leaves off. Its application, as applied to the natural gas industry, is more direct, as it is used for treating so-called "dry gas." Numerous public service corporations have installed absorption plants and have become gasoline producers, whereas they formerly merely were suppliers of natural gas.

So-called "dry" natural gas for years has been known to contain gasoline. With the introduction of compression stations on natural gas-pipe lines to force the gas to consuming centers, and the subsequent cooling of the gas after compression so that the lines could carry more of it, what is called "drip," which is gasoline, assumed considerable proportions at some stations.

As with casing head gas, the gasoline content in "dry" gas becomes higher as production wanes and the pressure, as a result, decreases. It is asserted that gas coming from some of the old wells in the East contains as much as one gallon of gasoline to 1,000 cubic feet. The quantity, however, may be as low as a pint, while some gases are practically devoid of gasoline content.

The absorption method consists of bringing the gas in contact with a heavy petroleum distillate, so-called mineral seal oil or straw oil usually being used. The oil absorbs the gasoline, as well as some of the heavier hydrocarbon bases. The oil then is pumped into a steam still and the gasoline is distilled out of the oil.

The oil then is returned to the absorber and the process repeated indefinitely, the oil being used over and over again as a carrier of gasoline from the absorber to the still.

Various devices are used for bringing the oil in contact with the gas, perhaps the most efficient method being a vertical absorber which the oil enters at the top, splashing downward against baffle plates in order to expose a large surface to the gas which enters the chamber at the bottom. The gas as it enters the chamber at the bottom first comes into contact with oil that already has absorbed some gasoline. As the gas travels upward it loses more and more gasoline, the last being absorbed by the fresh oil that is entering at the top. The hot oil from the stills is cooled before it again enters the absorber.

It may be said that every oil or gas well

drilled is a potential producer of gasoline, aside from that extracted from crude oil through ordinary refining methods. In this phase of the industry the limit still is far ahead—opportunities for profit lie in every gas and oil field. As refining methods become still more efficient, and economies become more rigid with reference to gasoline in natural gas, the percentage of gasoline produced as related to the production of crude oil unquestionably will assume surprising proportions.

X

TRANSPORTING AND MARKETING

PRODUCING oil without adequate transportation facilities would prove about as successful a financial venture as would raising California peaches for the New York market without refrigerator cars.

Likewise the refinery must have facilities adequate for the transporting to it of crude oil and from it of refined products both for domestic and foreign markets.

There are numerous refineries on the Atlantic seaboard to which oil is pumped through pipe lines directly from the Mid-Continent field. From the docks at these refineries vessels are sent to all parts of the world loaded with refined products.

As the oil industry has been developed, likewise have been developed transportation facilities adequate to handle the oil as it is produced and the refined products that have been made ready for the markets of the world.

TRANSPORTING AND MARKETING

There are three methods by which bulk petroleum at present is shipped—through pipe lines, by tank cars and in tank steamers.

Most important of these methods, and, according to the investigation of the Federal Trade Commission, the most economical, is through pipe lines. Certain conditions, however, make necessary the use of railways and steamships. These latter two methods prevail in the shipment of refined products, and sometimes are used for the transporting of crude oil.

Tank steamers are necessary, for instance, to ship crude oil from the Mexican fields to the refineries of the United States.

Producers far removed from pipe line systems are compelled to use tank cars, at least until adequate pipe line facilities have been provided.

When petroleum first was produced in America—in the Oil Creek district of Pennsylvania—the crude product was transported in iron-hooped wooden barrels. Teamsters hauled the barrels to Oil Creek and the Allegheny river. The cost of this method of conveyance now would be regarded as appalling. For transporting a barrel containing 40 or 42

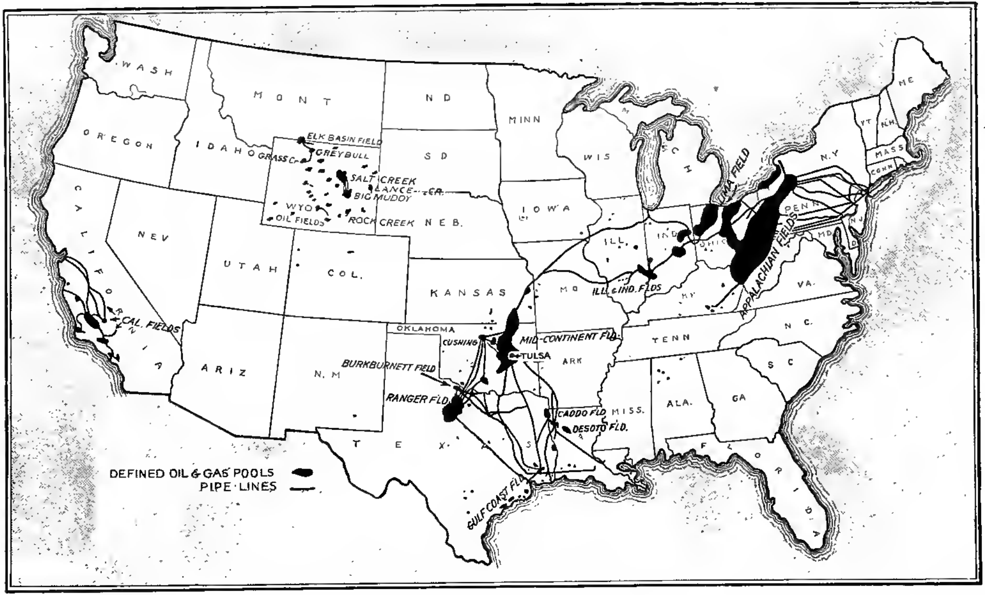
gallons, the cost sometimes ran as high as \$3 for a distance as short as four miles.

According to the report issued by the Federal Trade Commission in the early part of 1918, the cost of piping the oil from the wells to the trunk lines of a pipe-line system usually ranges from 3c. to $5\frac{1}{2}$c. a barrel. Oil was pumped to the vicinity of Chicago from the Cushing Pool of Oklahoma, the Commission found, at a cost of 11 cents a barrel including depreciation. This is a distance of about 700 miles.

The cost of main or trunk line transportation depends both on the length of the line and the aggregate volume of shipments. The Commission found, for instance, that the cost of pipe-line transportation from the Cushing pool to the Gulf of Mexico, a distance of 500 miles, did not run less than 16 cents a barrel.

The tariff at the time the Commission's investigation was made was 42 cents a barrel from Oklahoma to Chicago and 40 cents from the Cushing pool to Port Arthur, Texas, on the Gulf of Mexico.

It is interesting to note what the Commission learned regarding comparative cost to



Defined Oil and Gas Fields and Principal Pipe Lines of United States

the shipper of pipe line and railway transportation. The railroad tariff on a barrel of oil from the Cushing pool to Kansas City, the investigators found to be 37 cents a barrel, 9 cents a barrel higher than the pipe line tariff. To Whiting, Ind., from the Cushing pool, the railroad tariff was found to be 62 cents, or 20 cents a barrel more than the pipe-line rate.

The greatest variation was found in tariffs to the Atlantic seaboard from Oklahoma. It was found that the tariff on a barrel of oil by rail was $1.40, or just twice the pipe-line tariff.

But, to get back to the genesis of oil transportation in the United States. With the opening of the early Pennsylvania fields, Oil Creek and the Allegheny river formed the only practicable routes to the refineries—crude affairs that were constructed soon after the finding of petroleum in Pennsylvania.

Empty boats were towed up Oil Creek by horses that waded in the stream. After the boats had been loaded they awaited a freshet to provide sufficient water to float them downstream, or, sometimes, the stream was dammed in order to deepen the water.

When a freshet occurred many boats would be floated down the stream together with great loss as a result of collisions and grounding. As many as 40,000 barrels of oil were sent down the stream during one of these freshets, but as a rule the amount was 15,000 to 20,000 barrels. The oil was transferred to larger boats at Oil City.

One historian of the oil industry asserts that at one time there were more than 1,000 boats, 30 steamers and 4,000 men engaged in this traffic. During a freshet in May, 1864, a jam occurred at Oil City in which 20,000 to 30,000 barrels of oil were lost.

This method of transportation having proved inadequate, expensive and wasteful, the pipe line gradually was developed. In Asiatic countries in ancient times pipe lines were constructed of bamboo stems, but this plan was not successful because of excessive leakage.

What is believed to have been the first suggestion in America that petroleum be transported by pipe line was made by S. D. Karns of Parkersburg, West Virginia, in 1860. Mr. Karns proposed to lay from Burning Springs to Parkersburg, a distance of

30 miles, a six-inch line through which oil would flow by gravity, the idea being to transfer the oil to Ohio river boats at Parkersburg.

Although the Karns line was not laid, L. Hutchinson of New York in 1862 laid a line on the Tarr farm to send oil over a hill to the refinery. The syphon principle was used to draw the oil over the hill. A year later, Mr. Hutchinson constructed another line three miles long to carry oil from what was known as the Sherman well to the railroad. Air chambers were provided on this line at intervals of 50 to 100 feet to equalize the pressure.

Neither of these lines proved successful, principally because of excessive leakage at the joints where the sections of pipe came together.

It is believed that the first successful pipe line was constructed by Samuel Van Syckle of Titusville, Pa., in 1865. He solved the problem of leaky joints by joining the sections of pipe with closely fitting screw-sockets. This line was four miles in length and the pipe was laid two feet underground.

After this it was not long until pipe-line history was made rapidly.

A Mr. Harley in 1865 and 1866 constructed a pipe line from Benninghoff Run and the Shaffer Farm. A short time later he organized the Pennsylvania Transportation Company and constructed a line from the oil fields of Pennsylvania to the Atlantic seaboard. A four-inch pipe line about 60 miles in length was laid in 1875 from the oil country of Southwestern Pennsylvania to Pittsburgh.

Teamsters and others who began to see their means of livelihood go glimmering with the building of pipe lines, opposed the development vigorously. This opposition was overcome mainly by the speedy punishment of persons detected tampering with the newly constructed lines.

By 1876 there were no less than eight or nine pipe-line companies operating in the oil regions.

At that time the oil was refined in most instances near the district where it was produced, but it soon was found that refiners at Cleveland, Pittsburgh, Buffalo, Boston, New York, Philadelphia and Baltimore were better situated for the marketing of kerosene and other petroleum products. Consequently,

the transportation of crude oil to these centers increased rapidly in importance.

The building of pipe lines to the seaboard was continuous from 1878 to 1882, with the result that the refining business carried on in or near the oil fields decreased, while large refineries were erected at the Atlantic seaboard and on the Great Lakes. Later, with the development of oil districts in Indiana, Ohio and Illinois, the lines were extended into these states.

When the Louisiana, Texas, Oklahoma and Kansas fields were opened, pipes lines were laid to the Gulf Coast. Also the Mid-Continent field, consisting of Oklahoma and Kansas, was connected with lines that were linked up with the already existing trunk lines to the Atlantic coast refining centers, as well as with refineries in the vicinity of Chicago.

The California fields naturally were given pipe-line connection with the Pacific coast ports, where the refining industry has become an important factor in the industrial structure.

Pipe-line systems now traverse the states of Texas, Louisiana, Oklahoma, Kansas,

Arkansas, Missouri, Iowa, Illinois, Indiana, Ohio, Pennsylvania, New York, West Virginia, Kentucky, Maryland and New Jersey. California has her own system of pipe lines, connecting the various fields with refineries on the coast.

Wyoming also rapidly is linking her numerous producing fields with the refineries by means of pipe lines.

Accurate data as to the total pipe-line mileage in the United States are difficult to obtain. It is estimated, however, at the gigantic total of 50,000 to 60,000 miles—or an amount sufficient to girdle the earth twice. A large part of this mileage is in trunk or main lines, while the total of small "gathering" lines extending to the wells would boost even this huge total considerably. New lines are being constructed continuously, the Ranger discovery causing an aggressive renewal of pipe-line activity.

Millions upon millions of dollars are invested in these pipe lines. The Federal Trade Commission in 1916 found that the average cost of building and equipping an eight-inch pipe line, based on the cost of constructing 2,200 miles of line by six differ-

ent companies, was approximately $9,000 a mile.

Steel prices, however, maintained a steadily upward trend in 1917 and 1918, making the cost of lines laid in those years very much higher than the Trade Commission estimate. Prices began a gradual decline with the cessation of hostilities in Europe.

It would appear, therefore, that the 50,000 or 60,000 miles of pipe line in the United States probably represent a combined investment that would not lack a great deal of reaching the immense total of $500,000,000.

The building and operating of a pipe line is an undertaking that requires not only a great deal of capital, but also a large amount of judgment. The ordinary producer, of course, can not have his own pipe line because of its prohibitive cost. Consequently, except in case of great companies which form complete producing, transporting, refining and marketing organizations, the transportation of oil by means of pipe lines is in the hands of companies that make that their exclusive business.

The pipe line is the connecting link be-

tween the producer and the refiner. The producer looks to the pipe-line company to keep the tanks on his leases empty and the refiner looks to the company to keep his tanks full of crude oil.

In a great many cases new oil fields are developed in territory far removed from transportation facilities. As soon, however, as a new field has been proved of sufficient importance to warrant the building of a pipe line to take care of its production, the pipe line men are on the ground.

First a survey is made from the field to the nearest point at which connection may be had with a trunk-line system or terminal. Rights of way are obtained, estimates are made concerning the volume of oil to be handled and then pipe, tanks, pumping machinery and other equipment, as well as material for the building of stations, is ordered.

In some cases surveys are made and rights of way obtained before the field has actually been developed to a basis of profitable production. In a case of this kind the pipe-line company simply holds its plans in abeyance until the field has been proved.

A notable divergence from this rule forms one of the romantic incidents of the oil industry. It is stated that when E. L. Doheny was developing the great oil fields of Mexico, he expended more than $2,000,000 on pipe line and other equipment before he had a barrel of production for the pipe line to handle. His judgment was vindicated, however, with the bringing in of the greatest "gusher" well of the world's history—Cerro Azul, with initial flow of 260,000 barrels daily.

As the oil business has developed, the size of the pipes used has increased. Formerly pipe 2, 3 and 4 inches in diameter was used. Now, however, a 6-inch pipe is regarded as the minimum size for a line 50 or more miles in length. The great proportion of trunk line mileage is of 6- and 8-inch pipe, but there are some lines in which 10-, 12-, or even 14-inch is used.

When a pipe line is to be laid, the first step is to clear the right of way of timber, brush and other obstructions. The pipe then is distributed and a crew of pipe-line layers put in the field. For an 8-inch line each crew numbers about 75 men, consisting

of a foreman, stabbers, tongsmen, ropemen, barmen, jackmen, etc. The outfit also consists of a movable camp in which the men are housed and fed. The line is laid above ground by this crew, which is followed by the ditching crew. This second crew buries the line in a trench 24 to 30 inches deep.

A pipe-line crew of the size mentioned is able to screw together in a day some 200 to 250 joints of pipe of an average length of 20 feet, or 4,000 to 5,000 feet a day. Some slack is left in the line to allow for expansion and contraction brought about by temperature changes.

When the line or a certain section of it has been laid and placed in the ditch, but not covered, it is tested with water at a pressure of 800 to 1,000 pounds to the square inch. This develops any leaks or weak spots in the line.

Usually stations on a trunk line are placed from 40 to 50 miles apart, an effort always being made to place them near a town or railroad and near an adequate water supply. The stations are provided with a pump house, a boiler house, office, manifold house, warehouse and at least two steel tanks of a

capacity of 37,500 to 55,000 barrels each.

The equipment of a typical station of the Texas Company includes from four to eight 175 horsepower water-tube boilers, supplied by either natural gas or oil as fuel; one pumping engine with 36-inch flywheel; two direct-acting compound duplex pumps; electric light plant and auxiliary machinery.

Included in a pipe line operating organization are general superintendents, district superintendents, superintendents of telegraph, chief engineer, superintendent of tankage, district foremen, gaugers, connection men, station engineers, station firemen, telegraph operators, station helpers and line riders.

At the main office is located an individual known as the oil dispatcher, whose duty it is to keep close check on the oil received and pumped, and a station will not start pumping except on his order.

An elaborate accounting system is supervised by the department agent. This includes the recording of the various transactions and the accounting each day for every bit of oil received and delivered.

Wooden tanks built by the producer on his lease receive the oil as it flows or is pumped from the well. These tanks are connected by the pipe-line company with its lines, and as the tanks are filled the pipe-line gauger is notified and he runs the oil, gauging and inspecting it as to quality, the producer or his representative being present as the gauger works and as he turns the tank on and off the line. The valve is sealed between runs.

The run tickets, showing the gauge and inspection, after being signed by gauger and producer, are forwarded to the pipe-line company's office for recording. As soon as the producer has received his run ticket he may sell his oil at the prevailing market price.

From the tank of the producer the oil is sent into the nearest pipe-line station tanks, the station reporting to the company's office the amount received from each district. Carefully computed tables for each producer and station tank are on file in the office and the amount received is checked with the runs.

The oil is pumped by the receiving station to the nearest trunk-line station, which, in

turn, sends it along the line from station to station until it reaches the refinery, or an ocean terminal where it is delivered to tank steamers.

It is estimated that a single 8-inch line will handle about 30,000 barrels of oil a day from gathering lines.

Used principally for the transportation of refined products are the tank cars. Frequently, however, tank cars form the only outlet for oil from an isolated territory. This is the situation at present in Wyoming and Montana, which have not yet been tapped by pipe lines that will give connection with seaboard points. It is believed, however, that the time is not far distant when this territory will have trunk-line connection to the East.

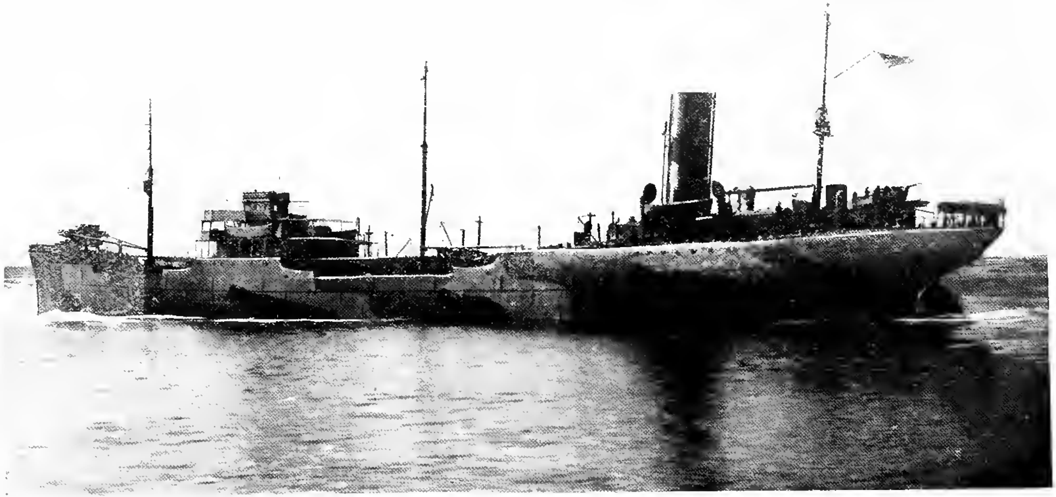
When tank cars are used, loading stations are provided at the producing property or refinery. The oil sometimes is fed into the cars from overhead tanks by gravity, while, in other cases, the fluid is pumped in from tanks at a lower level. The same systems are used in emptying the tank cars, depending on the elevation of the receptacles in which the oil is to be placed.

Practically every refining company that makes any pretension of being well equipped owns a large number of tank cars.

One concern in California confines its business entirely to the operation of tank cars. It was reported in 1918 to own approximately 19,000 tank cars, which are leased to shippers at rental charges according to capacity. In addition the company receives a mileage rate from the railroads. Most refining companies operate large fleets of tank cars in which both crude oil and finished products are transported.

Some tank cars are divided into compartments for transporting different kinds of refined products. Others are bulk carriers with facilities for carrying only one kind of oil. The capacity of the tank cars ranges from 3,600 to 12,500 gallons.

Where facilities are available for water transportation, it has been found much more economical to use this method than to ship by rail. It is the only means, for instance, of transporting crude oil from the fields of Mexico to the refineries and consumers in the United States and other countries. They are absolutely necessary to the development



Oil Tanker "J. W. Van Dyke"
Length 451 feet, capacity 3,592,490 gallons—also burns oil as fuel

of an export trade, and this phase of the industry recently has caused America's oil-carrying fleet to be enlarged materially.

For the marketing of refined products the large refining companies maintain distributing stations at the leading cities throughout the country. Some of these installations receive the refined products in bulk, packing them in the container deemed best to meet the needs of the retail trade. Through foreign subsidiaries some of the larger companies maintain large marketing organizations in all parts of the world.

Oil in bulk, in barrels and as "case goods" is sent to these foreign stations, from there to be transported by rail, river barges, cart or coolie perhaps to the interior of India or China.

Many companies in connection with their distributing stations throughout the United States maintain large sales forces and fleets of motor trucks and horse-drawn vehicles. The distributing systems work right down to the individual motorist and the purchaser of a five-gallon container of kerosene.

Even in the rural districts the fuel needs of the tractor, gasoline engine and automobile

are taken care of by the oil company's tank wagon, a stock of lubricating oils also being carried. There is no need of any one seeking far when in need of petroleum products, for the retail stores form an important adjunct to the marketing system—especially for the highly specialized products. Curb pumps at frequent intervals in the cities make the purchase of gasoline by the motorist most convenient.

Although it may readily be seen that the pipe line is the most important single element in oil transportation, the tank cars and tank steamers are equally as important in their spheres. Without tank steamers it would be practically impossible to develop an export trade of great dimensions.

If there were no tank cars there would be little chance of the oil producer being able to market his production before the building of pipe lines, to market excess production above what it is possible for the pipe lines to carry, or for the refiner to ship the products of his plant in bulk.

All of them are necessary and vital to the great petroleum industry.

XI

OIL—PRESENT AND FUTURE

Economically the petroleum problem is not one of demand, but of being able to supply the demand. Even though production has been gaining substantially for a score of years, the demand has grown even more rapidly, with the result that prices in 1918 and early in 1919 were at the highest figure since the industry had gained a scope that could be regarded as anything more than local.

And, according to Mark L. Requa, director general of the Oil Division of the United States Fuel Administration, crude oil prices, under the stress of war demand, would have gone even higher had not the law of supply and demand been temporarily abrogated and a system of price regulation adopted. He asserted that the situation in his opinion really warranted higher prices.

And again, in further proof that the petroleum industry was not dependent on war for its rapid growth in prosperity, are the figures

on production of copper, iron ore and steel as compared with oil for the similar periods just preceding and during the war.

Statistics show that in the four years just preceding the war copper production gained 10%, iron 2% and steel 9%, while during the war period the increase for copper was 50%, for iron 42% and for steel 57%. On the other hand the gain in oil production in the pre-war period was 31%, or more than any of the metals mentioned, while, during the war period the output gained only 32%, or much less than any of the other minerals. That the war rate and the pre-war rate were practically the same is significant.

The 1918 production figure means oil marketed from the wells. It does not include some 27,000,000 barrels taken from storage tanks of producers and pipe-line companies. Nor does it take into consideration some 36,500,000 barrels of oil shipped into the United States from Mexico. About 5,500,000 barrels of crude oil were exported. Which means that the domestic consumption, even after subtracting 20% for exports of refined products, was approximately 323,000,000 barrels—or between three and three and one-

half barrels for each man, woman and child in the United States.

Until 1916 it was possible to keep the production of crude oil ahead of consumption, thereby permitting the storage of large quantities of unrefined oil to meet future eventualities. This practice also served as a price stabilizer. But in 1916 the consumption for the first time forged ahead of production.

The surface reserves of crude petroleum in the United States at the end of July, 1916, were estimated at 189,283,766 barrels. By the end of 1916 they had been reduced by 15,000,000 barrels, the estimated total being 174,028,351. The reduction in 1917 amounted to about 24,000,000 barrels, while the reserves in 1918 were drawn upon to the estimated total of 27,000,000 barrels.

The surface reserves, therefore, in two and one-half years were reduced from 189,283,766 to 123,000,000 barrels, a total reduction of more than 66,000,000 barrels. This means that in the period from July, 1916, to the end of 1918 there were consumed in the United States and by her export customers 66,000,000 more barrels of petroleum than the fields produced in that period.

How vast has become the demand for petroleum is indicated by the fact that the country's production in 1898 was 55,364,233 barrels.

This means a gain in 20 years of more than 500%. Each succeeding year in that 20-year period showed a substantial increase, with the single exception of 1906. The gain in 1918 over 1917, despite the almost desperate effort that was made, was only a little more than 3%. So, while the demand for petroleum continues to gain momentum, the rate of increase in production has slowed up very perceptibly.

The production of the United States in barrels of 42 gallons each by years from 1860 to 1918, inclusive, follows:

1860	500,000
1861	2,100,000
1862	3,000,000
1863	2,600,000
1864	2,100,000
1865	2,500,000
1866	3,500,000
1867	3,300,000
1868	3,600,000

1869	4,200,000
1870	5,300,000
1871	5,200,000
1872	6,200,000
1873	9,900,000
1874	10,900,000
1875	12,200,000
1876	9,100,000
1877	13,300,000
1878	15,400,000
1879	19,900,000
1880	26,200,000
1881	27,600,000
1882	30,500,000
1883	23,400,000
1884	24,200,000
1885	21,900,000
1886	28,000,000
1887	28,200,000
1888	27,600,000
1889	35,100,000
1890	45,800,000
1891	54,300,000
1892	50,500,000
1893	48,500,000
1894	49,300,000
1895	52,900,000

1896	60,900,000
1897	60,500,000
1898	55,300,000
1899	57,100,000
1900	63,600,000
1901	69,300,000
1902	88,700,000
1903	100,400,000
1904	117,200,000
1905	134,700,000
1906	126,500,000
1907	166,100,000
1908	178,600,000
1909	183,200,000
1910	209,700,000
1911	220,400,000
1912	223,000,000
1913	248,300,000
1914	265,700,000
1915	281,100,000
1916	300,700,000
1917	335,300,000
1918	345,500,000

The relation of the motor car to the demand for gasoline is indicated by the fact that in 1914 the gasoline production was 34,915,000

barrels, while the output of gasoline in 1918 is estimated to have been more than 85,000,000 barrels, of which only about 13,500,000 barrels, or 15% was exported. The aeroplane and other speed devices using the internal combustion engine now are accentuating vastly this demand.

Total exports of petroleum and petroleum products in recent years follow: 1913, 50,870,612 barrels valued at $149,316,409; 1914, 53,334,120 barrels valued at $139,900,587; 1915, 55,445,848 barrels valued at $142,491,669; 1916, 62,083,124 barrels valued at $201,732,563. The exports in 1917 were 63,121,865 barrels, while in 1918 they were 66,004,363.

The gradual growth of the export figures indicates that the intrusion of war conditions into the situation late in 1914 did not increase the export movement beyond its normal rate of growth—this even though the United States supplied 80% of the petroleum consumed by the Allies.

The proportion of fuel and gas oil, gasoline and naphthas, crude oil, lubricating oils, and paraffin to the total exports did, however, increase from 1913 to 1918. The governing

factor in this, of course, was that ordinary export channels were neglected and war need became all-important. The exportation of gasoline and naphthas in 1918 was 565,819,-341 gallons as compared to 188,043,379 gallons in 1913. Fuel and gas oil exports grew from 359,008,618 gallons in 1913 to 1,123,-473,047 gallons in 1917 and 1,202,342 gallons in 1918. The crude oil increase was slight, being from 194,569,634 gallons in 1913 to 203,410,393 gallons in 1918.

The exports of lubricating oils and paraffin in 1918 were 257,372,942 gallons as against 207,639,902 gallons in 1913. Exports of illuminating oils decreased from 67,-863,775 gallons in 1913 to only 1,240,535 gallons in 1918.

But, while the percentages of gasoline and naphtha and other products increased, so also did the production of these various fuels. And the motor cars of the United States were compelled to go on short fuel rations in order to provide the export supplies.

Then, too, the domestic consumers in Europe and other countries that ordinarily look to America for petroleum were forced to do without.

Regarding the future of the gasoline situation, oil men are confident that the demand will continue so keen as to absorb the production in as great quantities as the wells and refiners are able to produce it.

For instance there was said to be a demand in the United States in 1919 for approximately 3,000,000 motor cars, while the manufacturers would be able to turn out perhaps half that number—or a total in one year equivalent to the entire number in use in 1914.

Already from 1914 to 1919 there had been a 300% gain in the number of motor vehicles, while oil production gained only 32%. The situation called for higher extraction of gasoline from crude oil by the refiners, as well as a very substantial growth in the casing-head gasoline industry. The "cracking" processes have been of invaluable aid in this respect.

The potentialities of the Mexican fields have been looked upon in some uninformed-quarters as boding ill for the production of gasoline from United States oils. It is well to recall, however, that the gasoline content of Mexican oils ranges from practically noth-

ing to 10%—or, perhaps, 15% if "cracking" is resorted to. Whatever gasoline is obtained from Mexican crude will be welcomed in order to help overcome the shortage that already appears imminent.

It is in the fuel oil division that Mexico is looked upon as the future savior. As before stated, there is developing an enormous demand for fuel oil for steaming and direct-heating purpose. This applies more particularly to the steamship lines, although there is a growing consumption by the railways and in the industries. Gasoline and fuel oils, therefore, are regarded as the staples of the industry.

The demand for kerosene, especially for export to the Orient, is large, while the need for lubricating oil and other products naturally must continue to increase.

The average yield of gasoline from the various refineries of the country may be said to be 25% or 26%, while kerosene is about 13%, gas oil and fuel oil 53% and lubricating oils slightly more than 6%.

The dominating part the United States is to play in the world commerce of the future not only will call for an immense growth in

the consumption of fuel oil, but will result in the development of new export sources of demand for any surplus of products not absorbed domestically—especially kerosene.

The number of American tank steamers at the beginning of 1919 was 230, compared with less than 100 in 1914.

That oil is superior to coal as a fuel, especially for maritime purposes, has been proved conclusively. It is estimated that, ton for ton, fuel oil has 30% to 60% more heating value than coal. It is also said to save at least 45% in bunker space. This saving would be even more if the oil were stored in the double bottom of a vessel.

It also is asserted that on large steamships such as the Aquitania and Mauretania the fire-room force could be reduced from 312 to 27 men. Cleanliness, increased travelling speed and rapidity in fuel loading are other advantages.

Regarding the supply of petroleum remaining in the fields already discovered in the United States, the Geological Survey has prepared the following table:

Oil Fields.	Marketed Production, 1917.	Marketed Production, 1918.	Total Marketed Production End of 1918.	Available Oil Left in Ground January, 1919.	Present Average Gas Extraction Per Cent.
Appalachian	24,932,205	25,300,000	1,221,737,000	500,000,000	28.0
Lima, Indiana	3,670,293	3,100,000	448,404,000	40,000,000	20.0
Illinois	15,776,860	13,300,000	298,159,000	175,000,000	22.0
Mid-Continent	144,043,596	139,000,000	990,573,000	1,725,000,000	24.0
North Texas	10,900,646	15,600,000	78,971,000	400,000,000	33.0
North Louisiana	8,561,963	13,000,000	90,902,000	100,000,000	28.0
Gulf Coast	24,342,879	21,700,000	303,054,000	750,000,000	1.5
Wyoming	8,978,680	12,370,000	39,793,000	400,000,000	40.5
California	93,877,549	101,300,000	1,114,000,000	2,250,000,000	12.0
Alaska, Colorado, Michigan, Montana, etc	230,930	230,000	10,651,000	350,000,000	
Total	335,315,601	345,500,000	4,598,144,000	6,740,000,000	

"The increasing use of oil all over the world and the consequent demand on present production," said W. C. Teagle, president of the Standard Oil Company of New Jersey, early in 1919," require the strictest conservation of existing resources."

One of the best evidences of increasing future prosperity in the oil industry was that some of the largest organizations in the country began in 1918 and 1919 an enormous program of refinery construction, especially along the Atlantic coast. The eastern seaboard previously had been the location of numerous large plants, the location being advantageous not only to meet the export demand, but also to supply the needs of the densely populated districts in that section of the country.

Some of the new plants are without pipeline connections with the fields in the interior of the country. They will receive their supplies of crude principally by tank steamer from Mexico and Gulf Coast ports of the United States. Oil from the immense new Ranger development for the new plants will be piped to the Gulf Coast and there put aboard vessels and carried to the Atlantic Coast.

In view of the Geological Survey estimates that about 40% of the known underground oil reserves have been exhausted, the question naturally arises as to where the oil industry of the United States is to obtain its oil after another decade or more.

It is unreasonable to believe that all the country's oil fields have been discovered—as witness the Ranger find. Also refining methods will continue to be improved, so that the percentage of desirable products will be increased. It is said that even now as high as 60% of gasoline, by the application of the most modern refining practice, is obtainable from some of the high-grade oils.

Then, as the amount of crude oil obtainable from wells decreases, there will come an increasing development of the oil shale beds that lie in the Western States—principally Colorado and Utah.

It is not at present profitable to treat these shales, which, in many cases, crop out on the surface. It will, however, be profitable as the price of petroleum products advances. In fact the practice of distilling crude oil out of shale has been profitably practiced in Scotland for many year.

Authorities assert that the amount of oil obtainable from the shale beds already discovered will dwarf into insignificance the huge total that has or will be produced from wells—they assert that the total will run into many billions of barrels. The amount of oil obtainable from the shale ranges roughly from one-half to one barrel from each ton of shale treated.

The progressive oil companies of the country when the time is ripe will enter this phase of the business—but this apparently will not be for some time.

That profits from the oil business are for only a chosen few is a fallacy that the investors of the country just now are beginning to appreciate.

It is true that John D. Rockefeller and his associates did hold the reins pretty closely for many years after Mr. Rockefeller first became interested in oil about 1865. But the industry became too large for one group of men to dominate it. Gradually there was room enough for others.

The opening of the Gulf Coast field gave the independent operators and refiners a real opportunity to gain a foothold. Then the

Government by the Supreme Court decision of 1911 ordering that the Standard Oil Company of New Jersey be broken up into numerous units, did much to clarify the situation and hearten the independent operators. The bugaboo was removed.

The Mid-Continent development was a case of "a fair field and no favorites." Independent producers, pipe-line companies and refiners operate as friendly neighbors with companies that belong to the so-called Standard Oil group.

And the profits accruing to these independent companies frequently are even larger in proportion to the capital invested than those registered by the Standard Oil organizations.

Concrete evidence of the appreciation in market value of securities of ably managed oil companies is embodied in figures regarding the Standard Oil companies. At the time of its dissolution by Supreme Court order in 1911, the Standard Oil Company of New Jersey was capitalized at $100,000,000 and the market value of its shares was $400,000,000. As against this amount, the market value of the various constituent

Standard Oil companies on May 1, 1919, was in excess of $2,500,000,000. This was a gain in eight years of $2,100,000,000, or 525%.

Nor are the profits of the Standard Oil Companies available to a favored few any more than are those of the independent companies. There are regular open markets for the shares and they may be purchased by any investor, just as may be obtained shares in other oil companies.

The oil business is not a closed proposition. It is a gigantic industry with profits available to anyone who will apply the ordinary principles of business judgment to his investment in oil company shares.

XII

SELECTING OIL SECURITIES

Among our greatest national assets is petroleum. It is stated by one statistician that the exports alone of oil and its by-products had up to 1919 reached a total of approximately \$4,000,000,000. And the exports at no time have averaged more than about one-fifth of the total—which would mean a total valuation on the country's output around the stupendous total of \$20,000,000,000.

The annual production of petroleum in the United States—with the greatest era of prosperity apparently just beginning—is said to be eight times as valuable as the annual output of gold. In fact it is estimated that it exceeds in value the total annual output of all other minerals—gold, silver, platinum, lead, zinc, etc., possibly excepting iron and coal.

That the percentage of success in oil-producing operations is high is indicated by the estimated results of 1918. The number of wells drilled in the United States in that year,

according to a well-known oil publication, is put at slightly less than 25,000, of which about 5,650 were unproductive and about 2,200 gas wells. It would seem, therefore that about 77½% were paying ventures—some of them vastly so. These estimates are not official. Some authorities consider the percentage too high.

This total is said to include wells drilled in unproven territory, where the chances of striking oil in many instances are decidedly scant. The reward is great, however, when oil is struck in new territory—and it is these pioneering operations that result in expanding the oil-producing areas.

What are the rules to follow in making investments that open the way to participation in the vast profits of the oil industry?

Sound business principles should be applied to the purchase of oil securities just as surely as they should be applied to the formation of a business partnership with a man or group of men. For the purchaser of shares of a company's capital stock becomes a partner in that organization.

Only too frequently, however, the would-be investor in oil securities permits a wealth of

adjectives to strangle his normal conservatism and good business judgment. This applies particularly to promotion literature of new companies that too frequently are organized for promotion profits rather than with the intention of conscientiously endeavoring to build up a profitable business. The result of such a "plunge" is that the money is put in first and the business analysis made afterward.

As in any other line of endeavor, securities that represent known earning ability, or, in other words, seasoned dividend payers, are the most desirable from a conservative investment point of view.

But the way to the greatest profits lies in the ability to discern the possibilities of a company in the constructive stage, or of a company that, already a profitable concern, faces an era of even greater financial success—with its attendant possibilities of stock distributions and greater dividend disbursements.

More important even than a new company's properties, in the opinion of successful oil investors, is the character, experience and business ability of the men in

charge of the company's affairs. It is a fact that many investments are based solely on faith in the management.

It not infrequently happens that properties that have real merit do not pay because of unscrupulous, inefficient or inexperienced management. These same properties have been made to return substantial dividends to the shareholders when placed in the hands of capable and honest men.

It is the plain business principle of knowing to what manner of men you are entrusting the administration of a part of your estate.

It is only following out the policies of sound business judgment to consult available sources of trustworthy information before arriving at a decision concerning the purchase of oil securities. Shares should be favored that are traded in definitely established markets, with regularly published price quotations.

The New York Curb Market is the largest market for oil securities in the world. It is there that the shares of the Standard Oil companies as well as numerous meritorious independent organizations find their market place.

Reliable brokers are prepared to supply

accurate information regarding the companies whose shares have a regularly established market place.

Next to its management, the location and possible value of a company's holdings have a vital bearing on its future possibilities. If there are no producing wells on the acreage, it should be learned if there are wells on adjoining tracts.

If there are wells on all sides of the property, or on three sides, the percentage of risk is very low; but it increases in ratio to the absence of wells in close proximity to the tract in question and the lack of geological evidence indicative of the presence of oil in commercial quantities.

If, in the case of a new company, the operations are to be conducted in unproven territory considerable distance from producing properties, the opinions of competent and reputable geologists, along with the presence or absence of oil or gas seepages or other surface indications, have to be depended upon.

That a majority of new oil pools are discovered as a result of geological investigation is shown by the fact that 31 of the oil

pools of Oklahoma and Kansas are said to have been discovered with the aid of geologists, while 26 are ascribed to the efforts of "wildcat" drillers without geological counsel.

In considering a company's production it is important to know something of the age and number of wells from which the oil is coming. Oil wells as they attain age decrease their production until they finally settle down to a steady flow.

In fact, a statistician for the Standard Oil Company of New Jersey in May, 1919, placed the average production of the 225,000 wells in the United States at only 4½ barrels each daily. Thousands of wells in the older fields, he said, produced less than one-quarter of a barrel daily, while something like four-fifths yielded less than one barrel each.

The writer recalls one especially good example of the importance of knowing whether the production is "flush" (new) or "settled," as well as something of the reputation of the district for dependability. When shares of the company's stock were offered for subscription the company had on one lease wells that were producing 4,000 barrels

a day. Eighteen months later, although several new wells had been drilled on the lease, its production had fallen to 60 barrels a day.

Sands of great thickness naturally prove to have the longest life as producers.

In this same connection it is well to consider the advantage of a great number of wells with "settled" production over a few at the "flush" stage. If a company has two wells producing 2,000 barrels a day, its risk is concentrated. Should one of the wells cease to flow, the income is cut in half. Likewise, as the wells undergo the natural settling process, the return becomes correspondingly less.

But suppose a company's 2,000 barrels a day of production comes from 200 wells instead of two. The low average production per well shows that the wells have passed through the settling process and are at a stage of steady output. Should one or two, or even ten, of these wells become worthless, the effect would not be serious. The company's risk has been scattered.

It also is obvious that a company that intends to expand and grow in prosperity over

a period of years can not accomplish that end by pinning its faith to one lease or even to one small productive district.

The young company should devote part of its profits to the acquisition and development of new leases—perhaps in a number of fields. The holding of properties in numerous districts, with acreage in reserve for future development, is the policy adhered to by the most successful producing companies in the country.

Transportation facilities play an important part in the development of a property and the lack of them sometimes holds back a small company's financial progress for an almost hopeless period. This has an important bearing not only on the obtaining of equipment for drilling, but also on the marketing of the production, if oil be obtained.

If the district is not tapped by a pipe line, nearness to a railroad is essential. The farther removed the property may be from existing pipe lines, the longer the delay and the larger the production that must be developed before a pipe line company is willing to provide marketing facilities. A pipe line company is a decidedly business-like institu-

tion and must have fairly conclusive evidence that the project will prove profitable before it will extend its lines into new producing territory.

An oil company that has production, but is unable to market it, is not an immediately profitable proposition.

Another important factor—again referring to a new company—is whether the company's financial resources are adequate to carry out the work that will be necessary before it becomes a self-sustaining, dividend-earning organization.

If it is a company already past the formation stage, its balance sheet and income account should be consulted. The question of funded debt also is essential.

If the company is just being launched, the investor should know something regarding the cost of the properties to the company; should estimate the amount of capital that will be placed in the company's treasury through the sale of stock, and then should judge whether this will be sufficient, without further financing, to put the company "over the hump," or on a paying basis. The prospective investor likewise should put himself

in a position to judge whether the company is overcapitalized.

Quality of oil and ability to maintain production are other important factors. Quality of oil is quite essential, as may be judged by the fact that on May 1, 1919, the price of the various grades of crude oil produced in the United States had a range of from 75 cents to $4.00 a barrel. The 75-cent price prevailed for certain grades of heavy, asphaltic oils produced in the Gulf Coast district. The $4.00 quotation was for Pennsylvania grade of crude. The same price was being received for oil from the Garber field of Oklahoma, for which there was being paid a premium of $1.75 over the posted price of $2.25 for Mid-Continent crude.

These are merely a few suggestions given in an endeavor to show that the ordinary rules of business apply to the making of an investment in oil just as surely as they apply to any other form of investment.

There is no question but that securities of bona fide oil companies form an immensely —and increasingly—profitable field of investment, but facts rather than adjectives should influence the decision.

A high-class, established and reputable dealer in securities should be consulted before (instead of after) buying. Such a securities house gathers basic facts regarding many companies and it is a part of its service to customers and prospective customers to give out those facts in an unprejudiced manner. The selection of the broker should be carried out with the same judgment that is applied to the selection of banker, lawyer or physician. For it is from the reputable securities house that the essential facts governing the profits to be derived from an oil investment may be obtained.

It is an immensely prosperous industry and the gate to this prosperity is open to the investor who reads correctly the signs that direct him to the gateway.